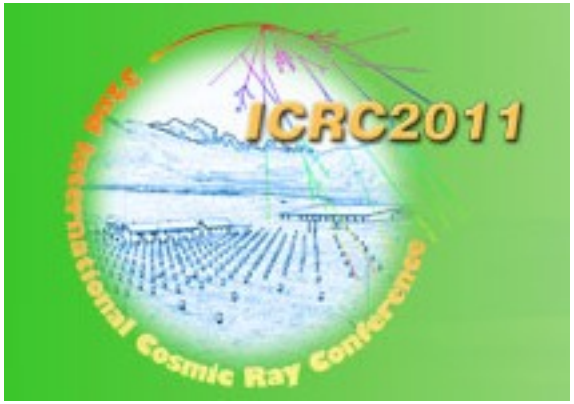
Résumé des conférences d'été

Matière Noire - Energie Noire

Ch.Yèche

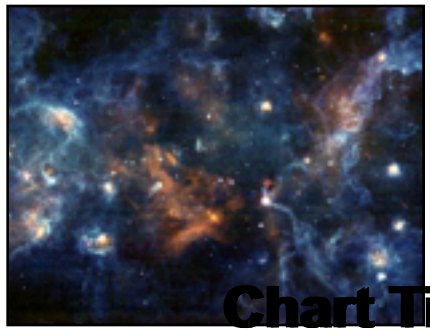
2011 MUNICH
TAUP
Topics in Astroparticle and Underground Physics

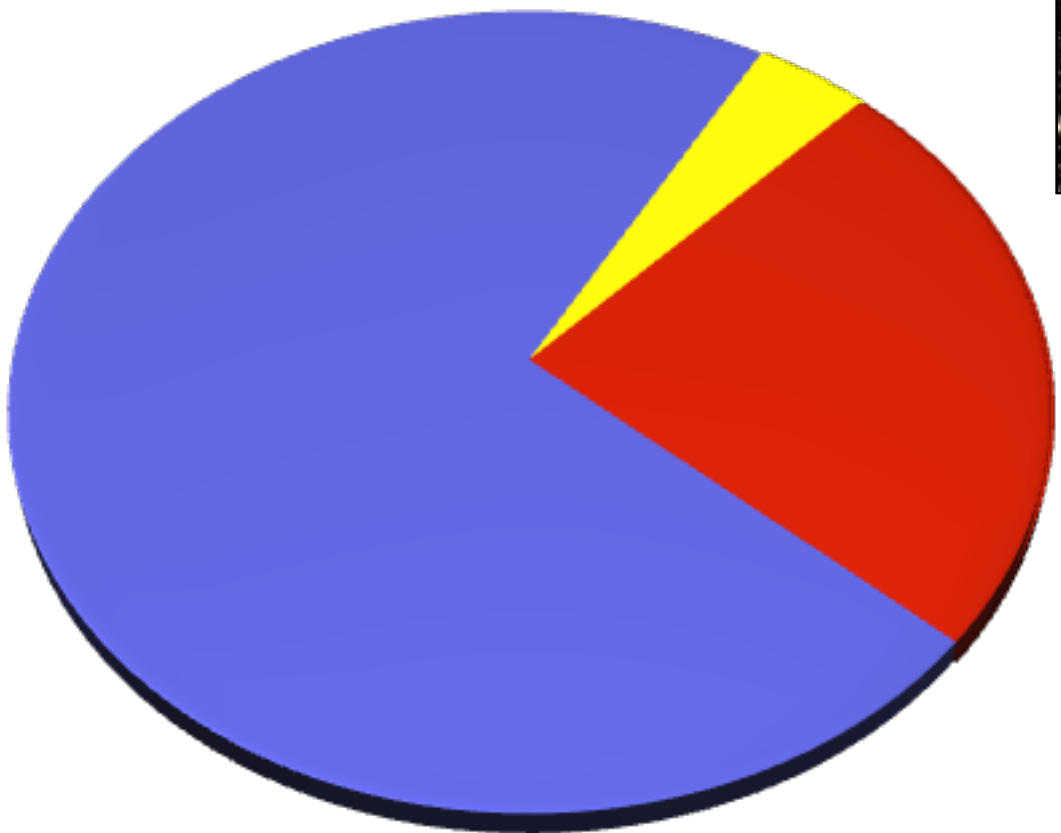


Merci à Eric Armengaud et Fabian Schussler pour leur aide!!!

Saclay, le 03 octobre 2011

Notre univers





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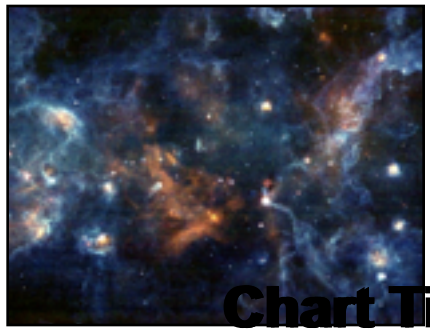

Matière ordinaire
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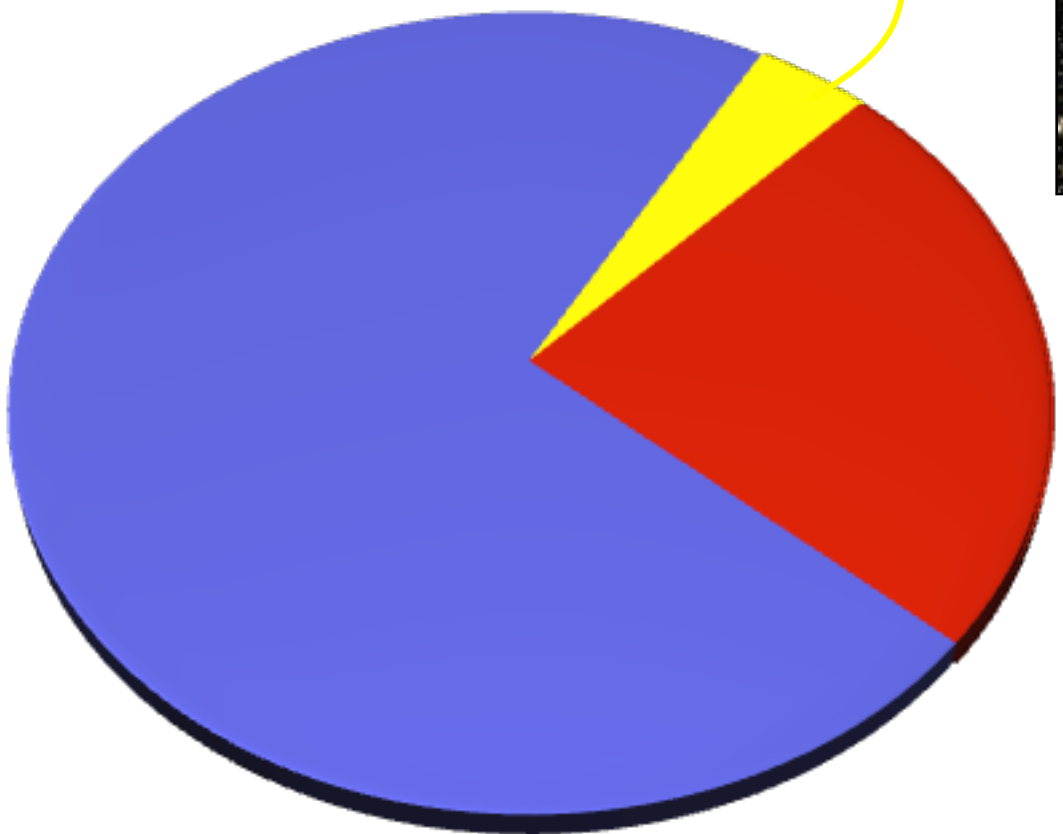

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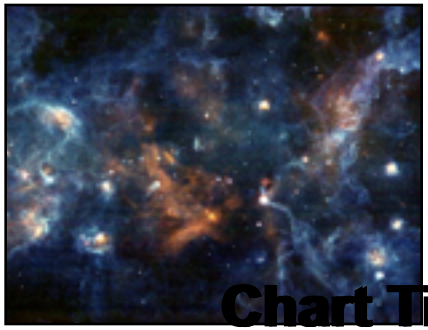

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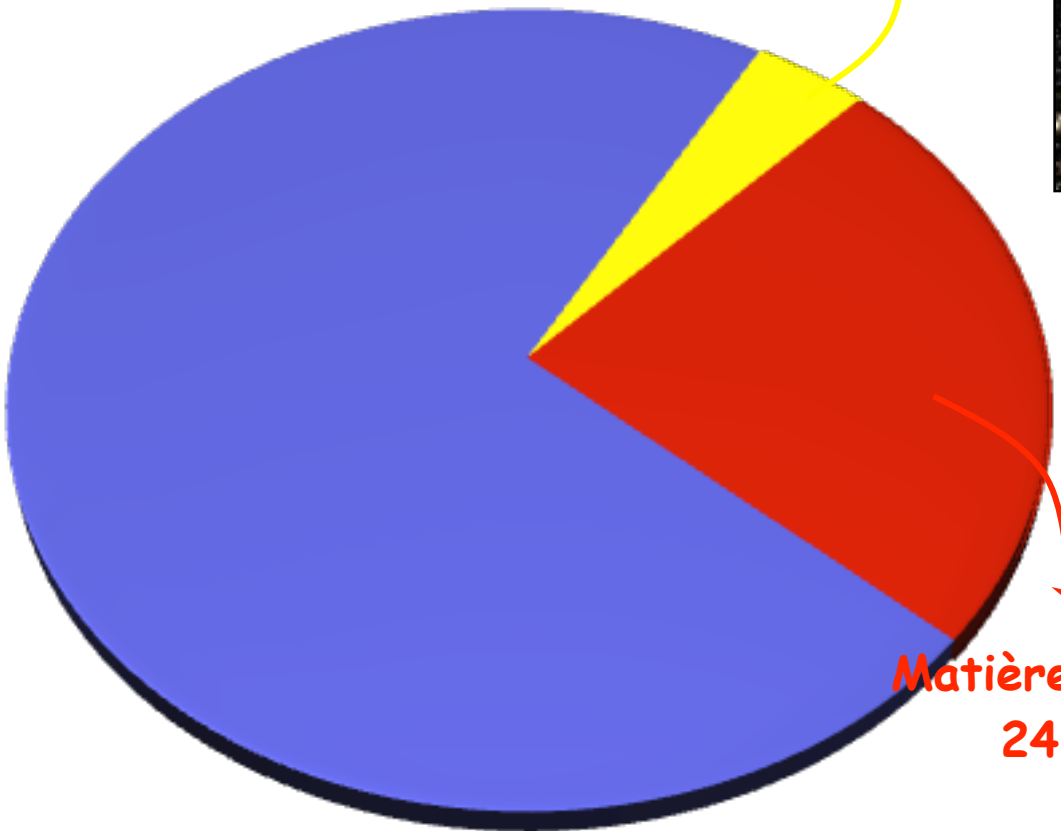

Matière noire
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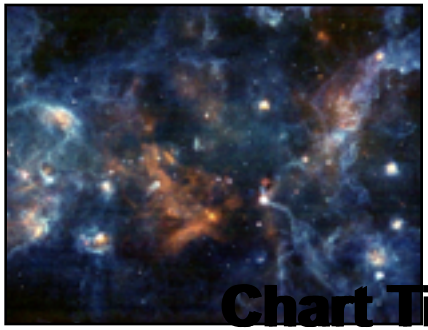
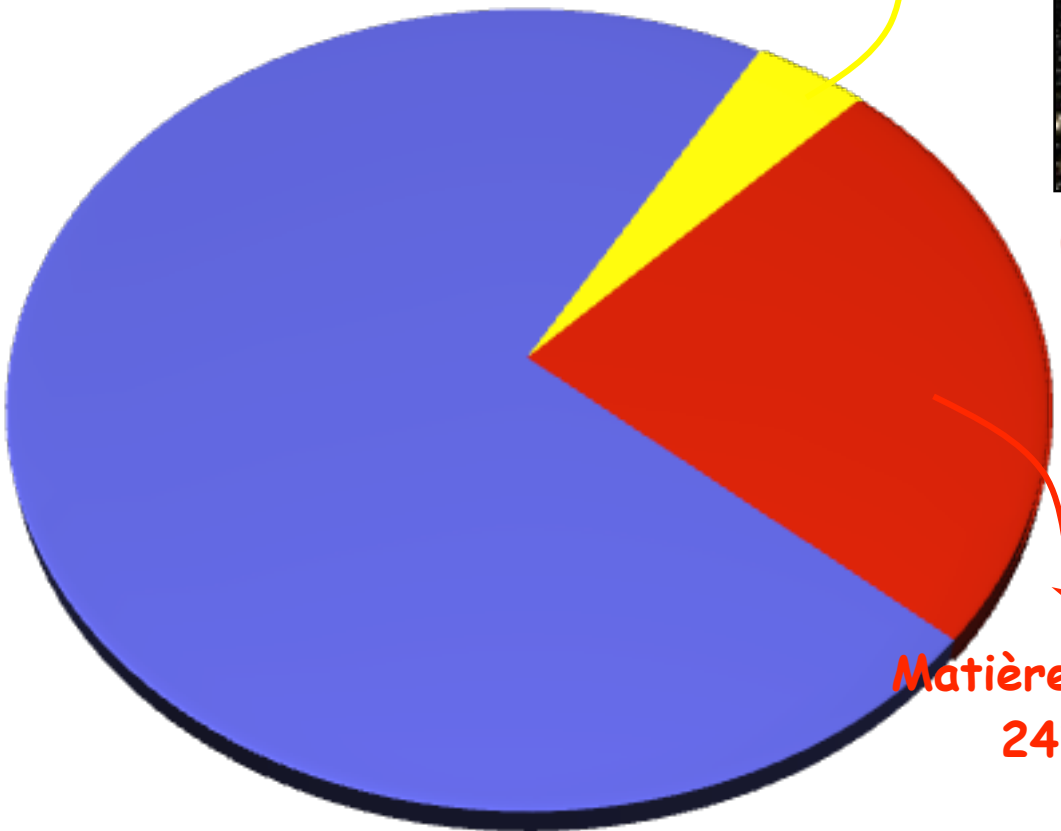
Notre univers



Matière ordinaire
4%

Recherche directe
Edelweiss
CDMS
Xenon100
Cresst
Cogent



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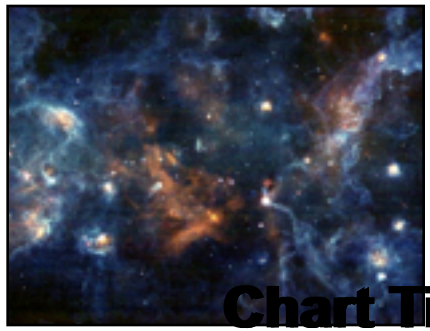

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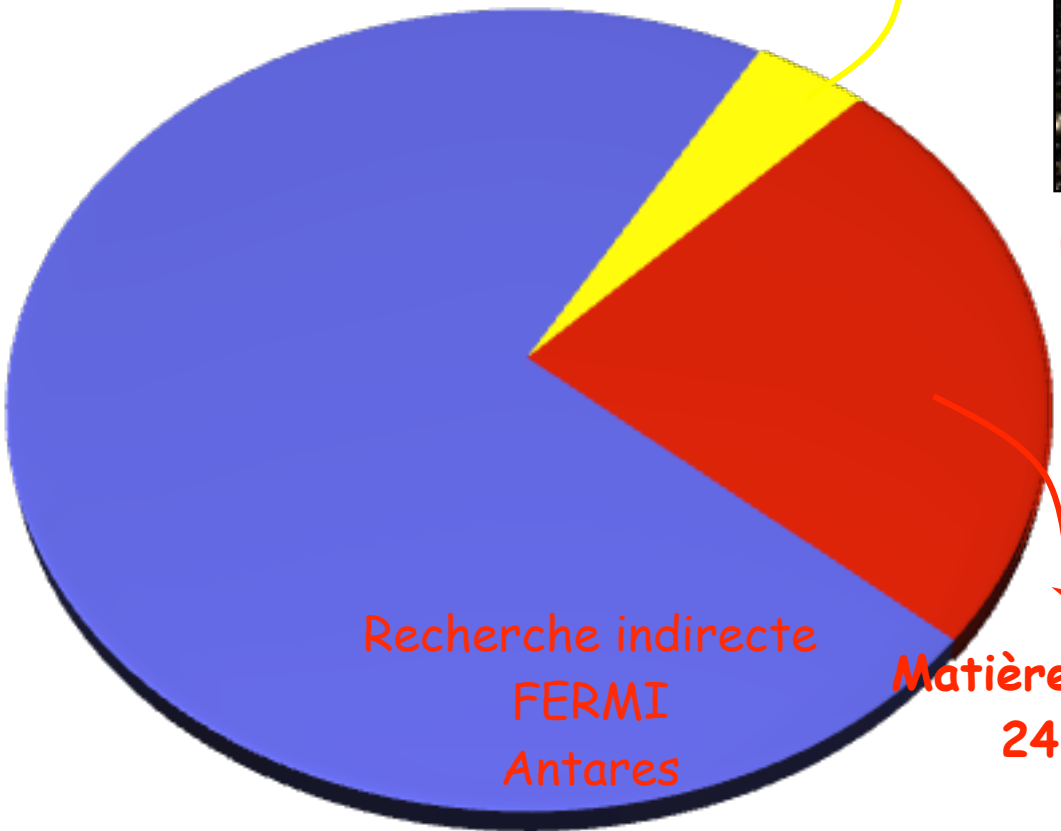
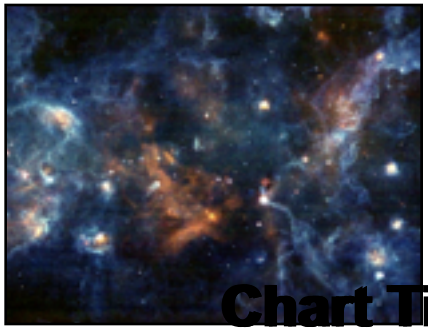


Notre univers



Energie noire
72%

Matière ordinaire
4%

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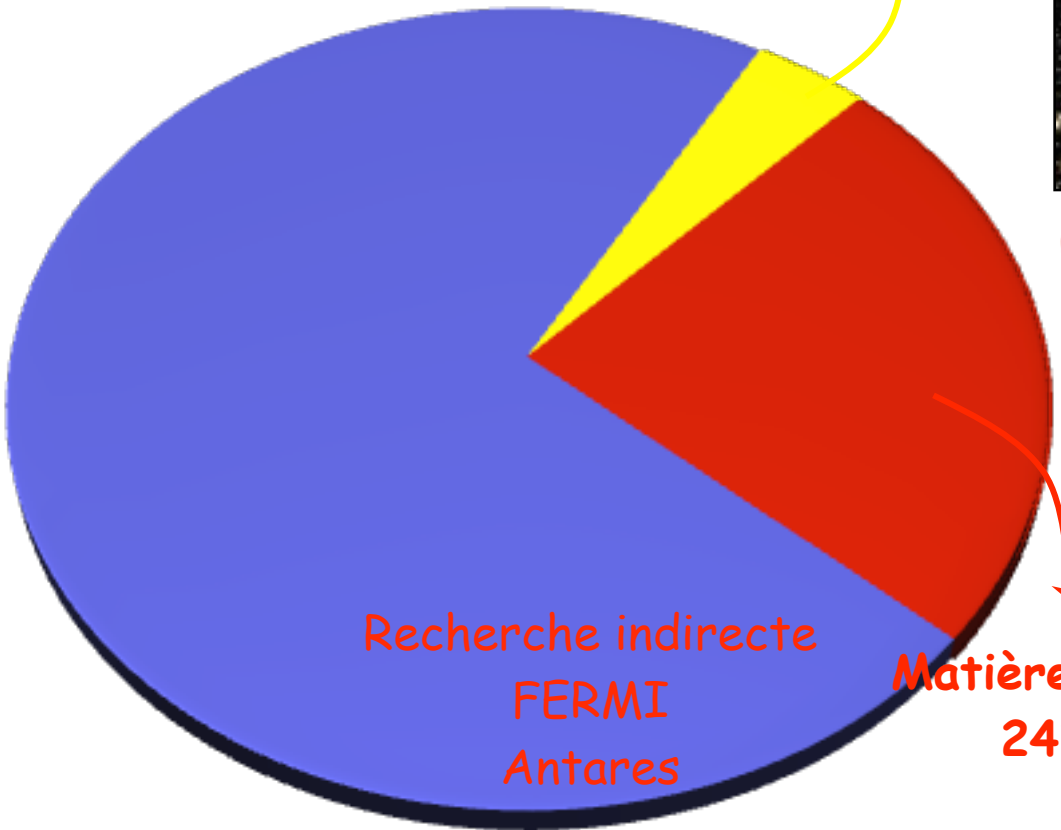

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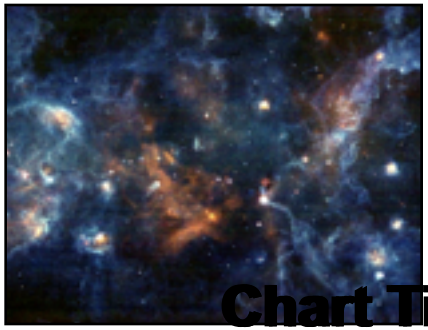
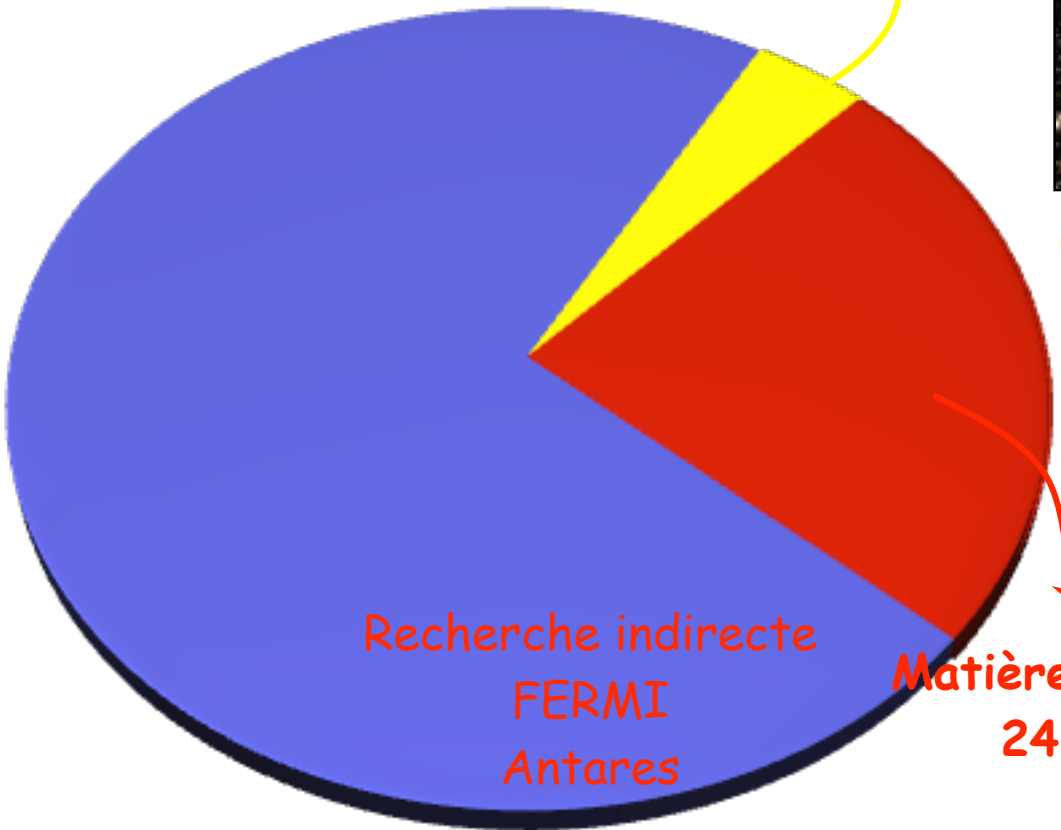


Energie noire
72%

Matière ordinaire
4%

SNIa
SNLS



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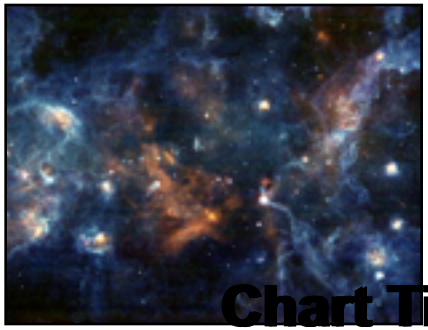

Matière ordinaire
4%

Energie noire
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Recherche directe
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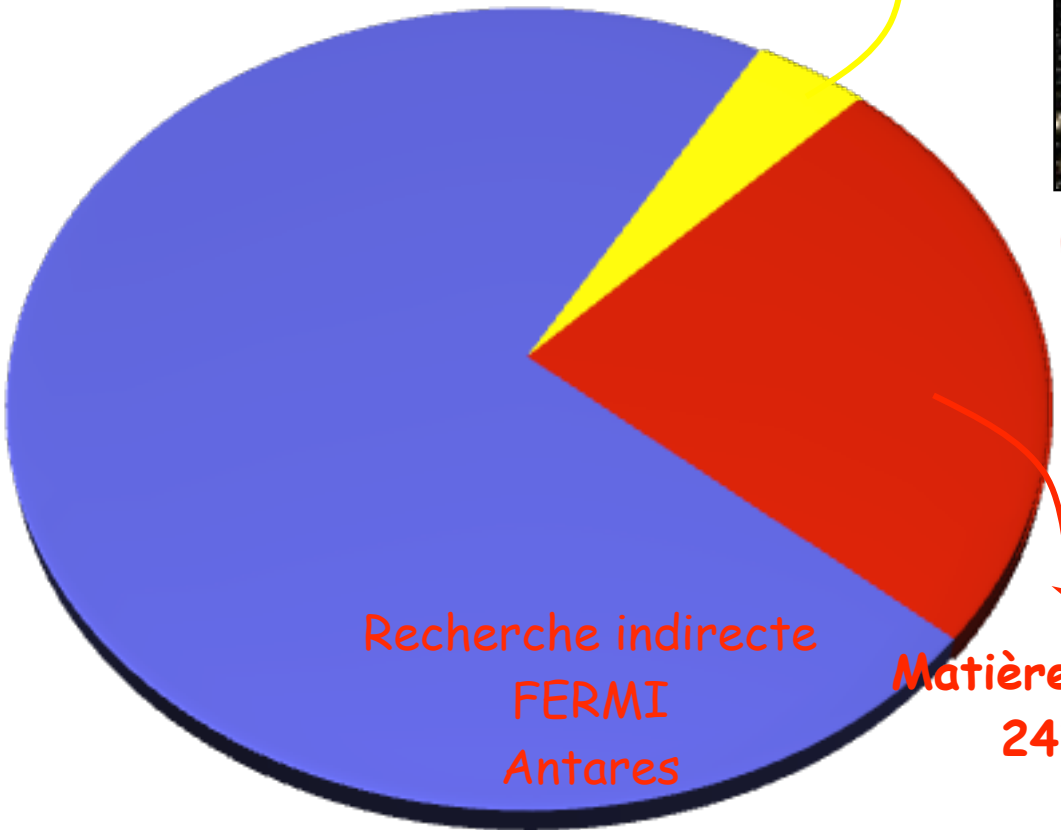
SNIa
SNLS

BAO
BOSS
Wigglez



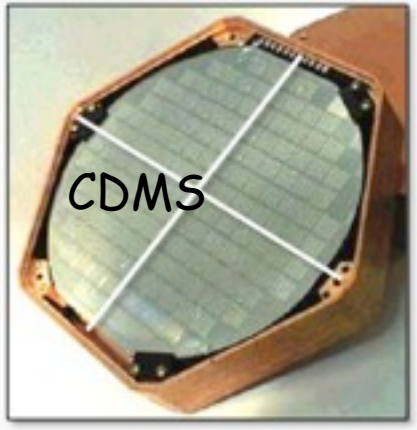
Edelweiss
CDMS
-

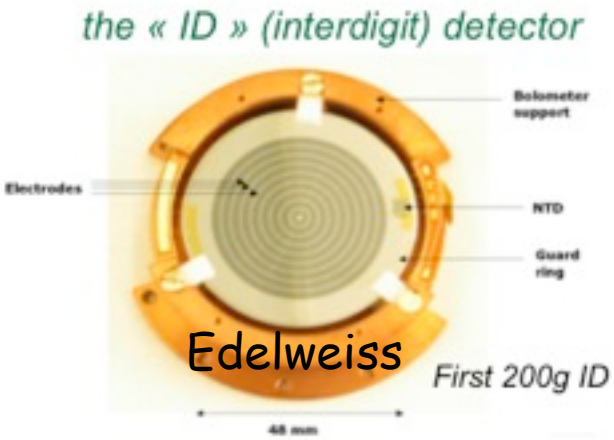
Eric Armengaud

Wolfgang Rau

Raphael Lang

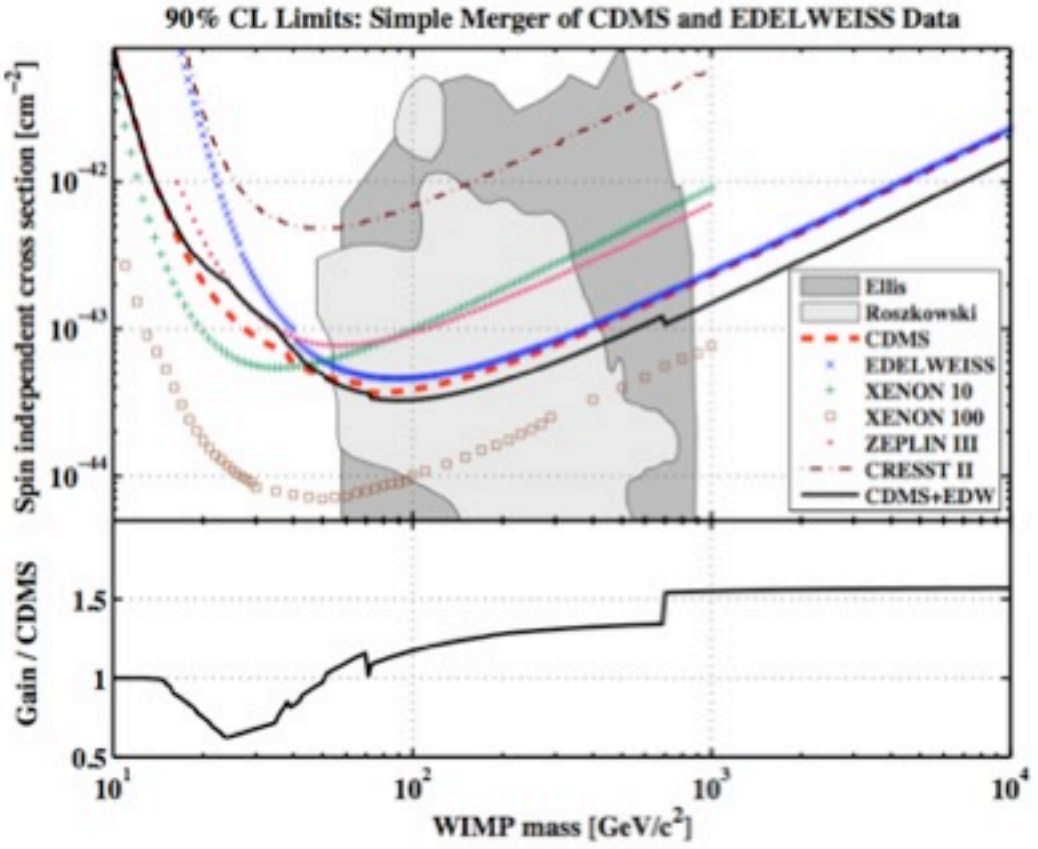
Combinaison CDMS-Edelweiss





- The use of the same target material allows simple combination of data.
- Simple merger of data sets was chosen prior to any analysis.
  - EDW: 384 kg.d, [20-200keV], 5 evts
  - CDMS: ~379 kg.d, [~10-100keV], 4 evts
- Other methods have also been tested.

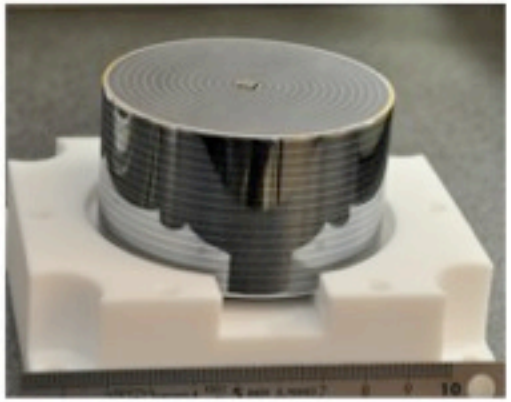
~50% gain at high WIMP masses.

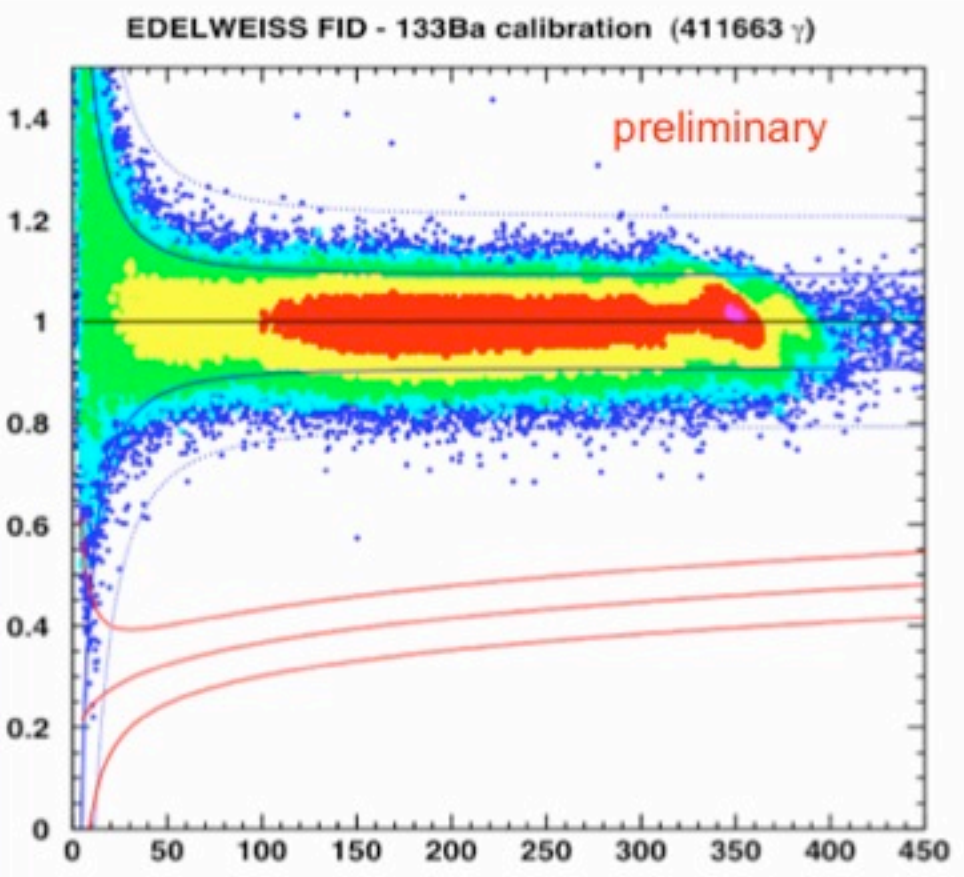


Phys. Rev. D **84, 011102 (2011).**

Better than ID : the FID800 detector

Edelweiss Futur





Strong improvement of the gamma-ray rejection over original ID detectors

Increase mass + sensitivity :

- 800g crystal
- two NTD sensors per detector
- interleaved electrodes on all the surface : no « guard » region anymore, ~ 75% fiducial volume
- eight detectors already in commissing

- Detectors : ~ 40 FID800 bolometers installed 2012 : **24 kg fiducial**

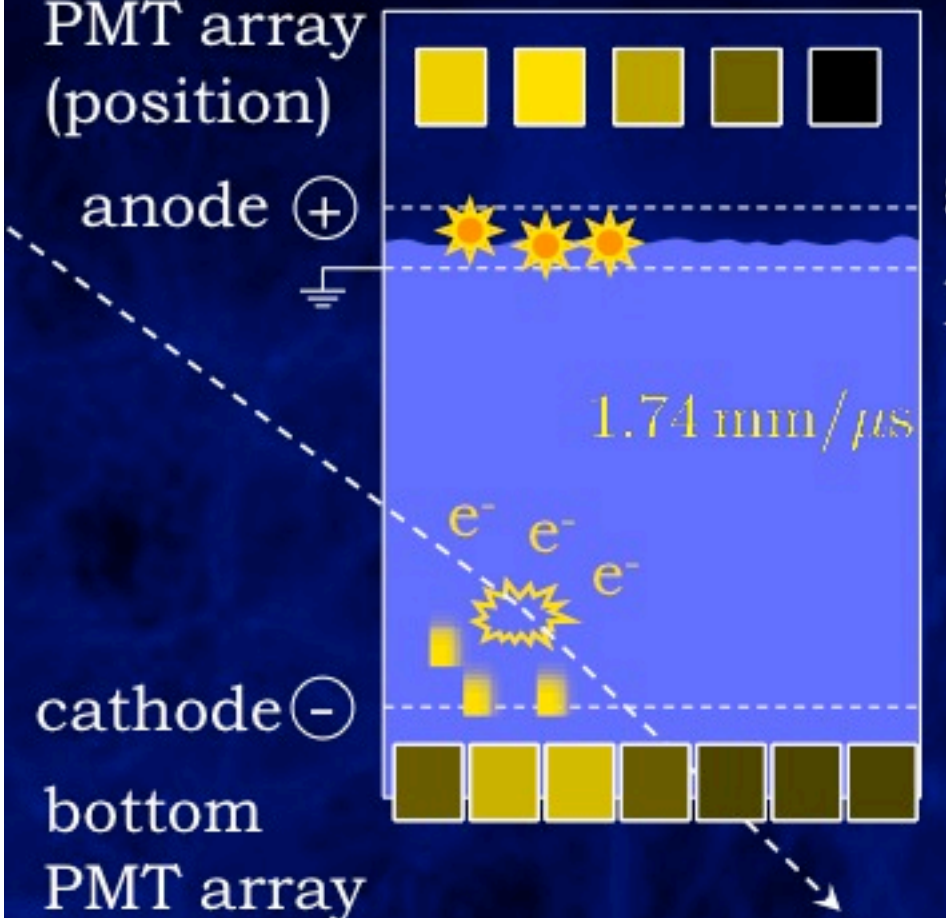
  ⇒ 3000 kg.d by end 2012

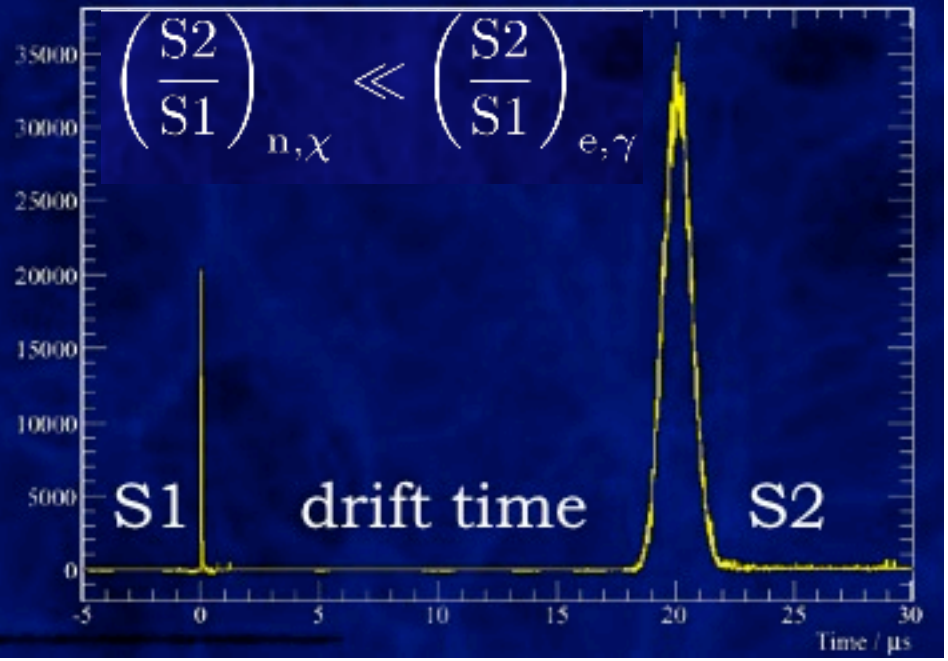
  (5×10^{-9} pb)

Xenon 100

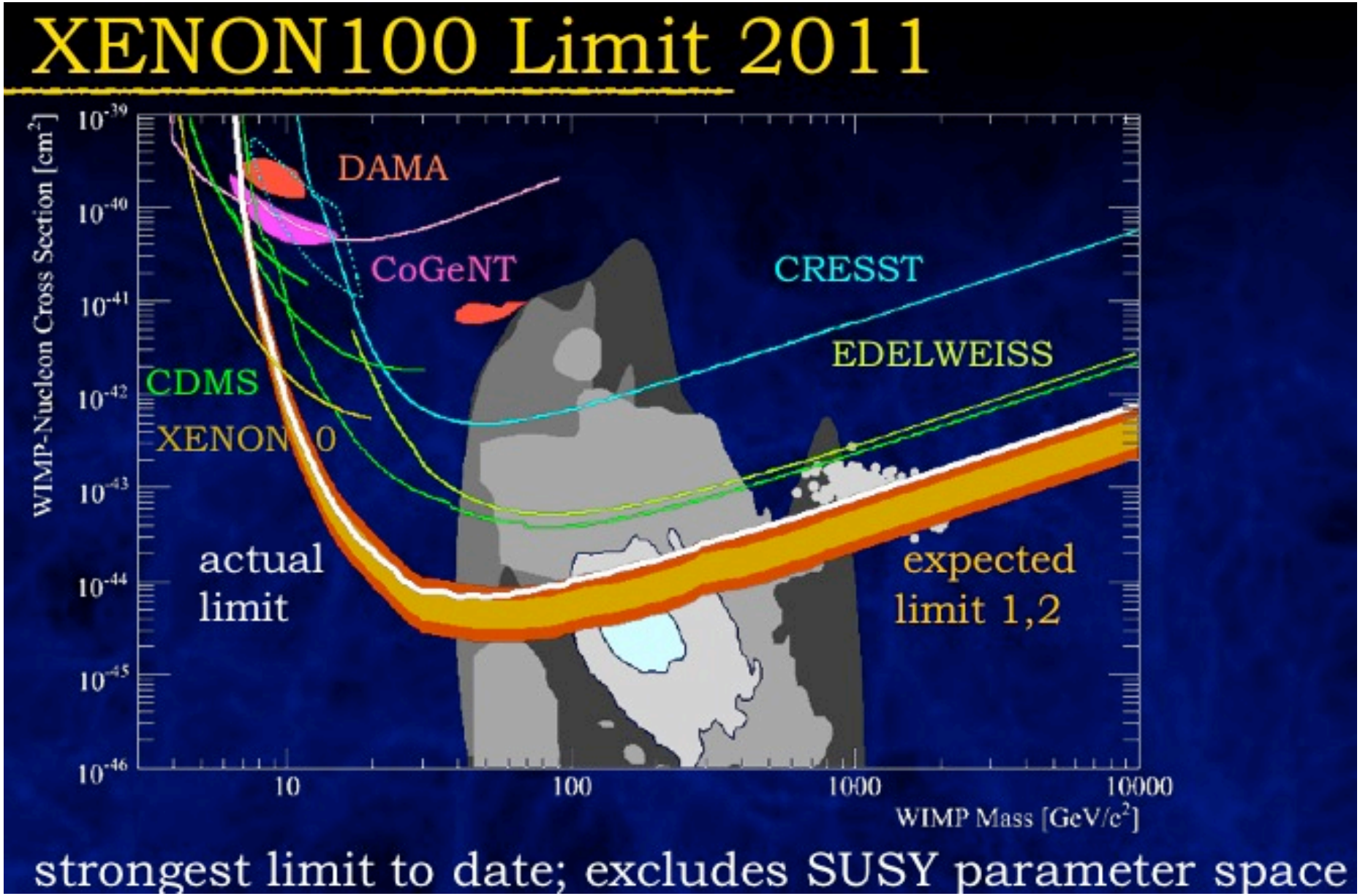
Dual-Phase Xenon TPC

3D position information
S2 hit pattern: $\delta r < 3\,\mathrm{mm}$
drift time: $\delta z < 300\,\mu\mathrm{m}$

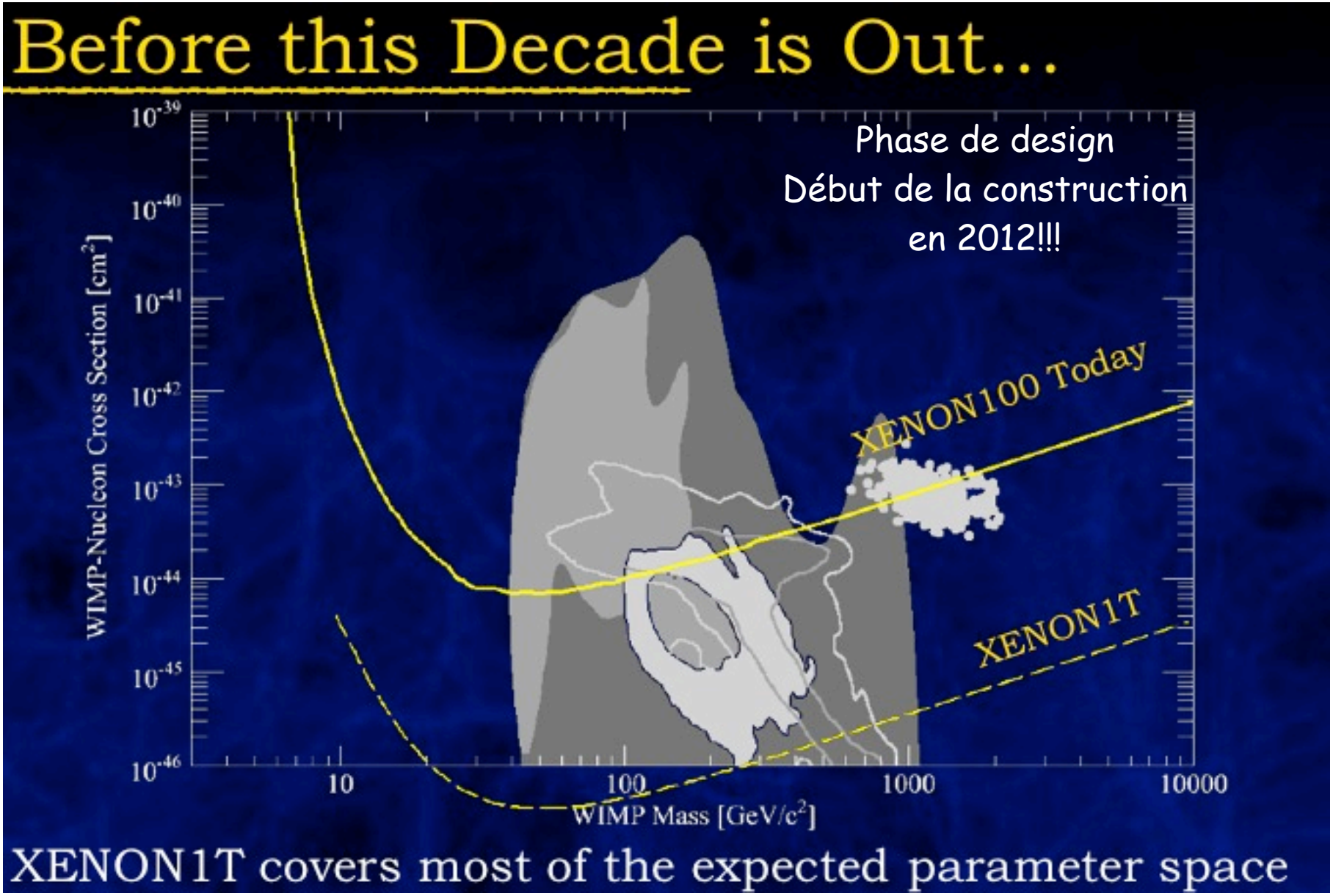




Xenon 100 Résultats



Futur Xenon 1T



Federica Preticca

Cresst

-

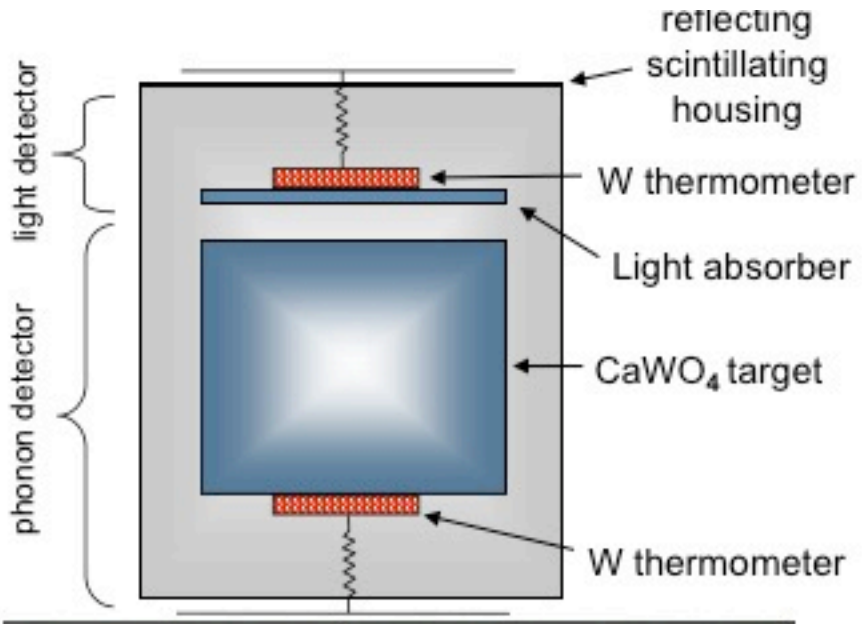
Juan Collar

CRESST-II

- Target crystals operated as ***cryogenic calorimeters*** (~10mK)
  - energy deposition in the crystal:
  - → mainly phonons
    - temperature rise detected with W-thermometers
    - measurement of deposited energy (sub keV resolution at low energy)
  - → small fraction into scintillation light
- Separate ***cryogenic light detector*** to detect the light signal

Detector module:

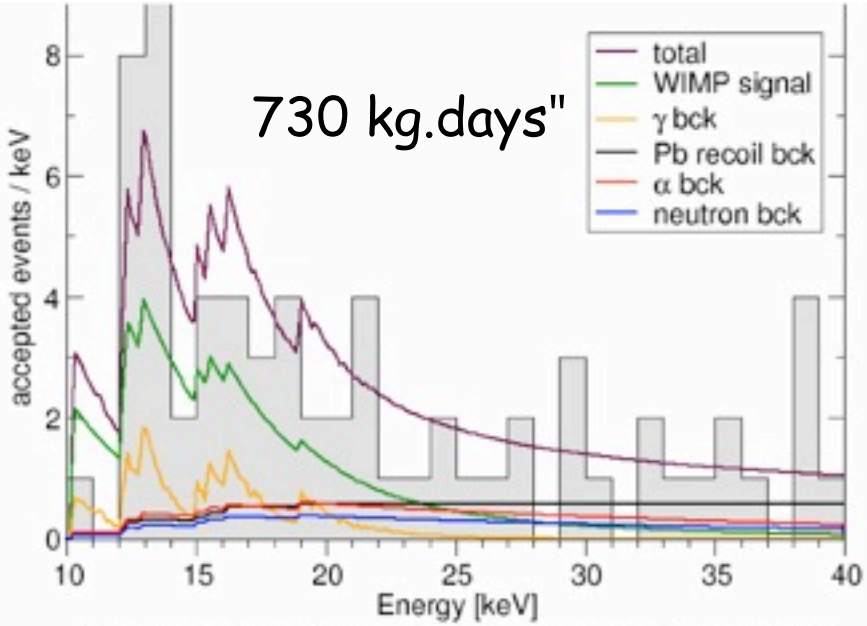
- Simultaneous measurement of:
  - →***deposited energy E in the crystal*** (independent of the type of particle)
  - →***scintillation light L*** (characteristic of the type of particle)

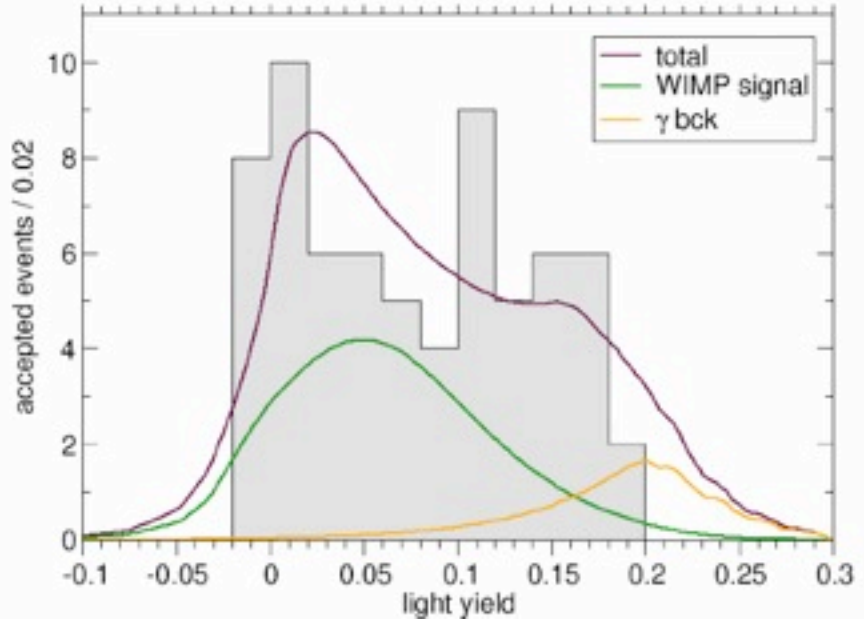


- Energy spectra of α, neutron or Pb backgrounds do not resemble the expected WIMP signal and only the *e*/γ contribution has a similar shape

- Light yield spectrum of *e*/γ differs significantly from the expected WIMP signal and thus cannot explain the total LY distribution

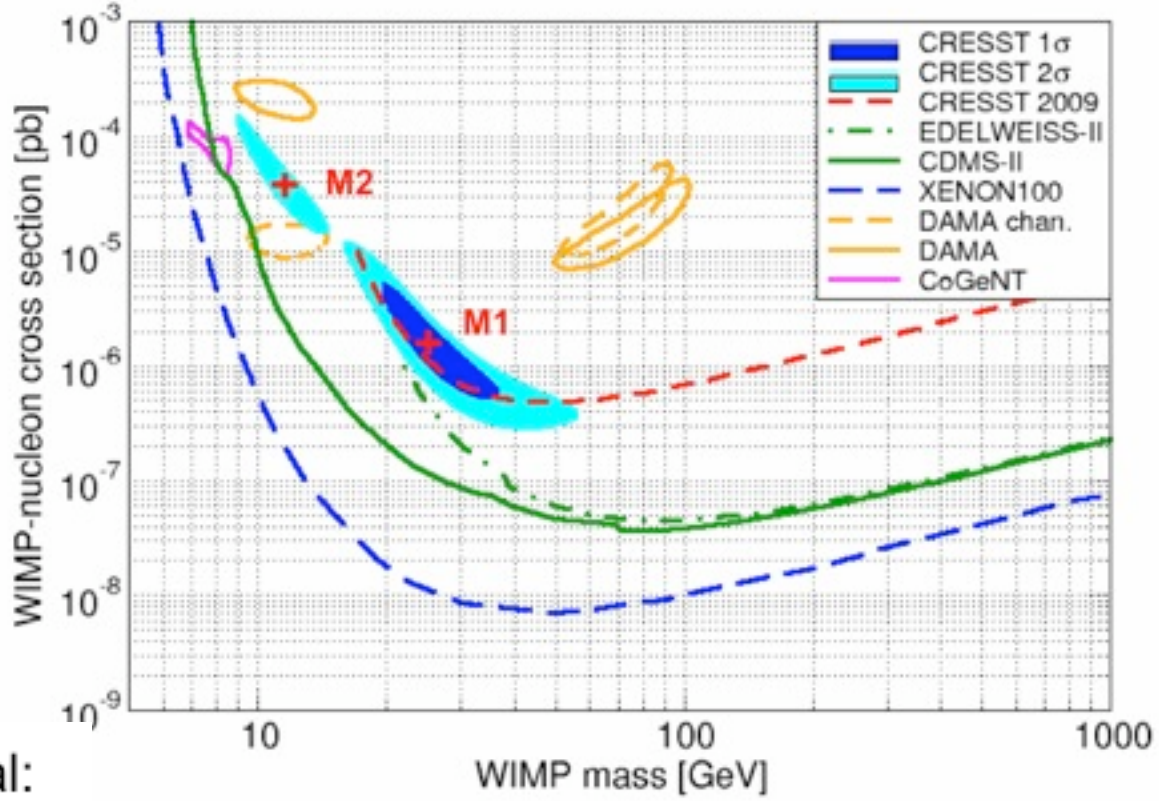
CRESST-II





CRESST-II Résultats

	M1	M2
e/γ events	8.00 ± 0.05	8.00 ± 0.05
α events	$11.5^{+2.6}_{-2.3}$	$11.2^{+2.5}_{-2.3}$
neutron events	$7.5^{+6.3}_{-5.5}$	$9.7^{+6.1}_{-5.1}$
Pb recoils	$15.0^{+5.2}_{-5.1}$	$18.7^{+4.9}_{-4.7}$
signal events	$29.4^{+8.6}_{-7.7}$	$24.2^{+8.1}_{-7.2}$
m_χ [GeV]	25.3	11.6
σ_{WN} [pb]	$1.6 \cdot 10^{-6}$	$3.7 \cdot 10^{-5}$



- Statistical significance for a signal:

4.7 σ for M1

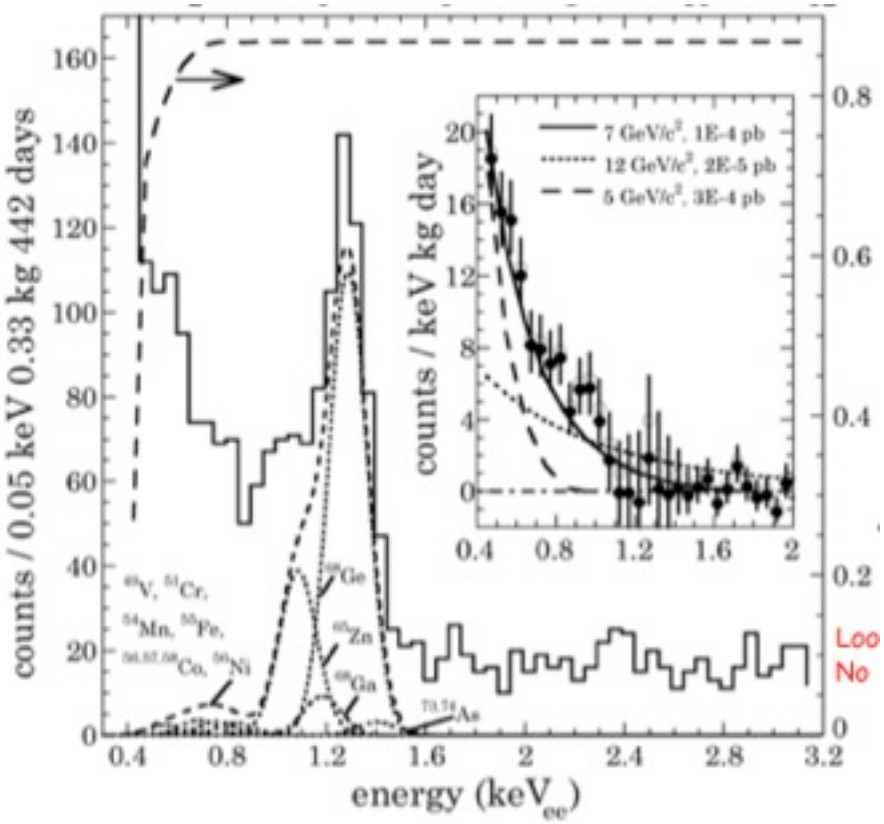
4.2 σ for M2

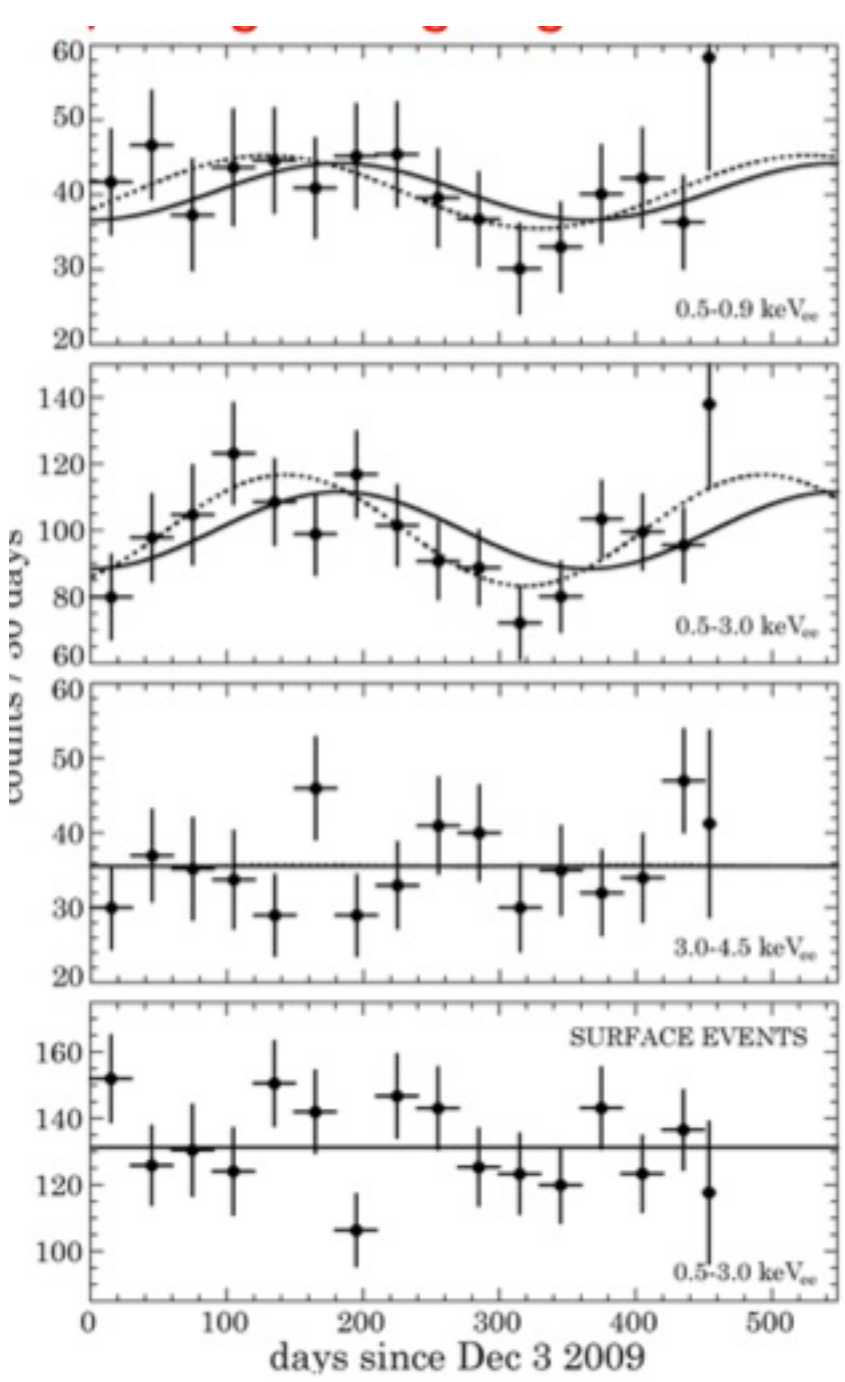
730 kg.days"

CoGeNT

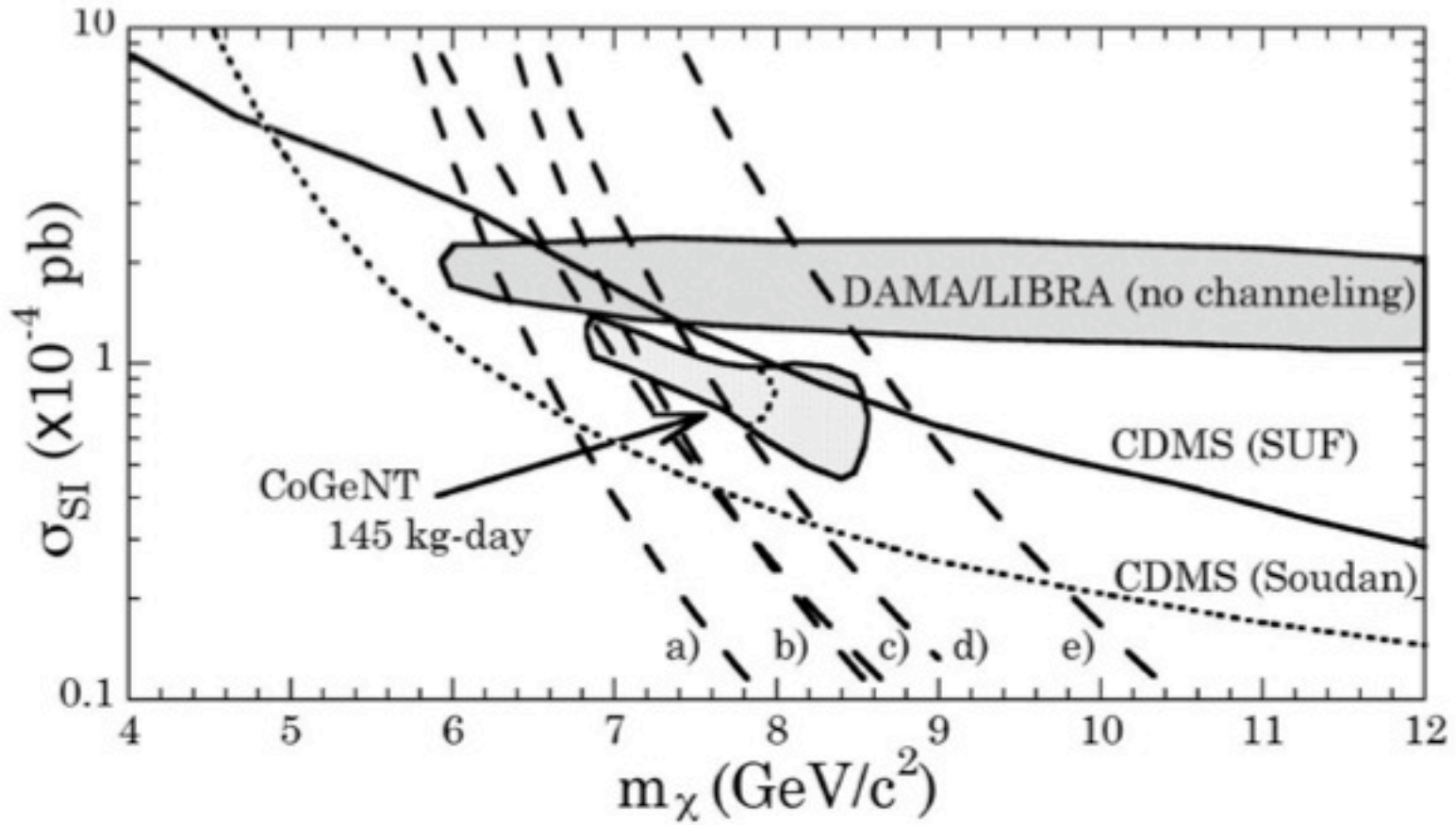
458 days collected (442d live)
Fiducial mass~330 grams

Phys. Rev. Lett., in press





CoGeNT -Résultats



- CoGeNT region considerably smaller than before (but within previous ROI), next to DAMA.

Beaucoup de transparents (surtout une critique des autres….)

Détection indirecte

Fermi

Pasquale Serpico

-

Rayon cosmiques

Fermi

P. Michelson

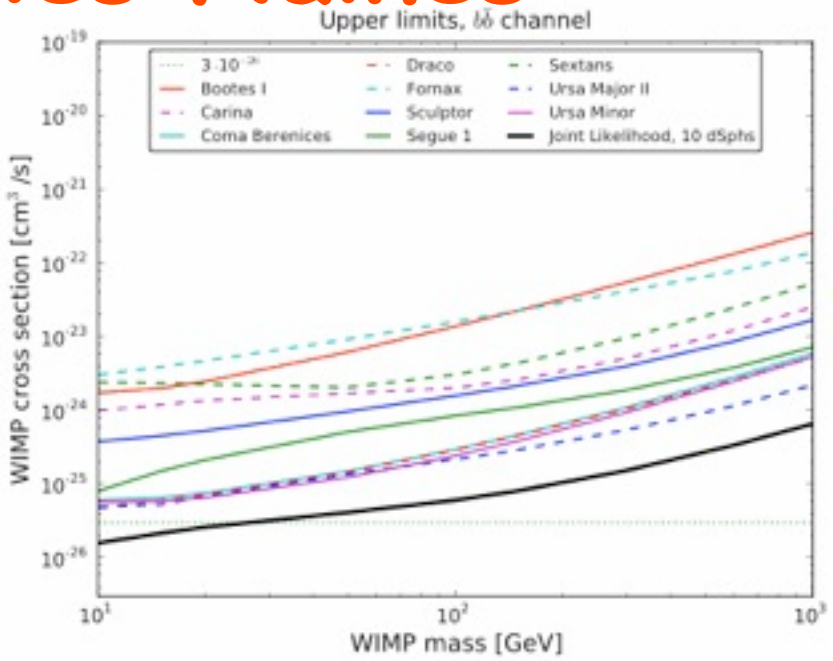
Antares

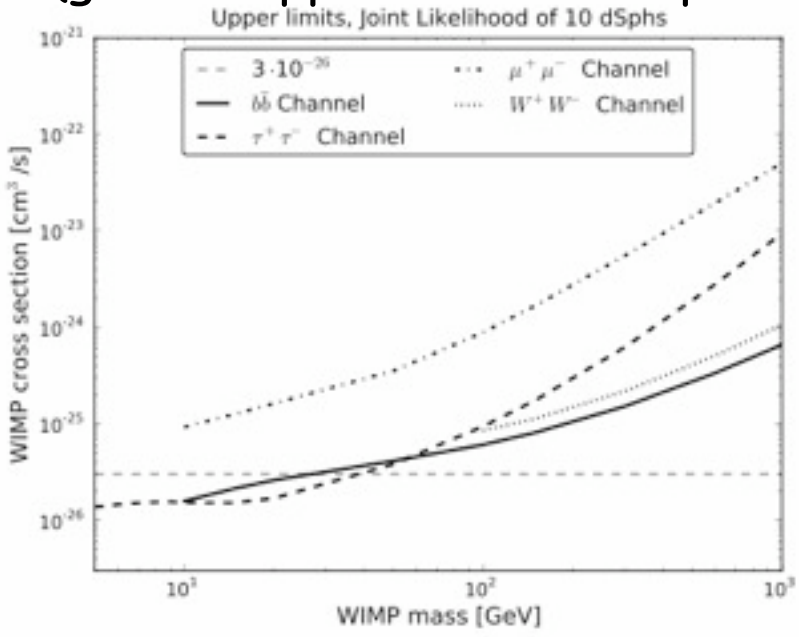
Claudio Bogazzi

Fermi - Galaxies Naines

Détection indirecte:

- Fermi satellite γ: 20 MeV - 300 GeV
- $\chi\chi \rightarrow \gamma\gamma$
- 10 galaxies naines (jusqu'à 140 kpc)
- Galaxies naines objets très favorables pour contenir de la DM (grand rapport M/L~400 pour Draco)



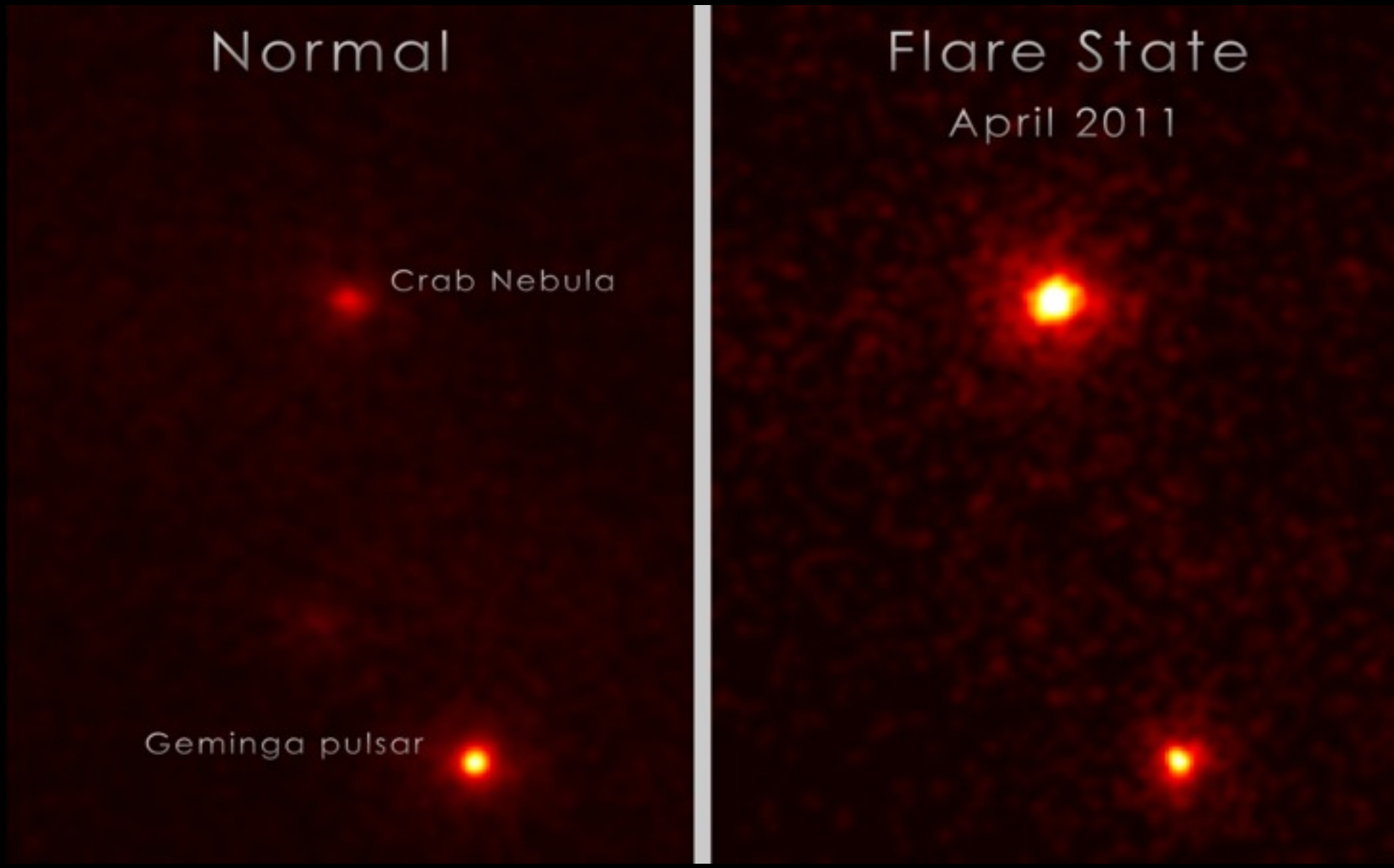


Test « cosmologique »:

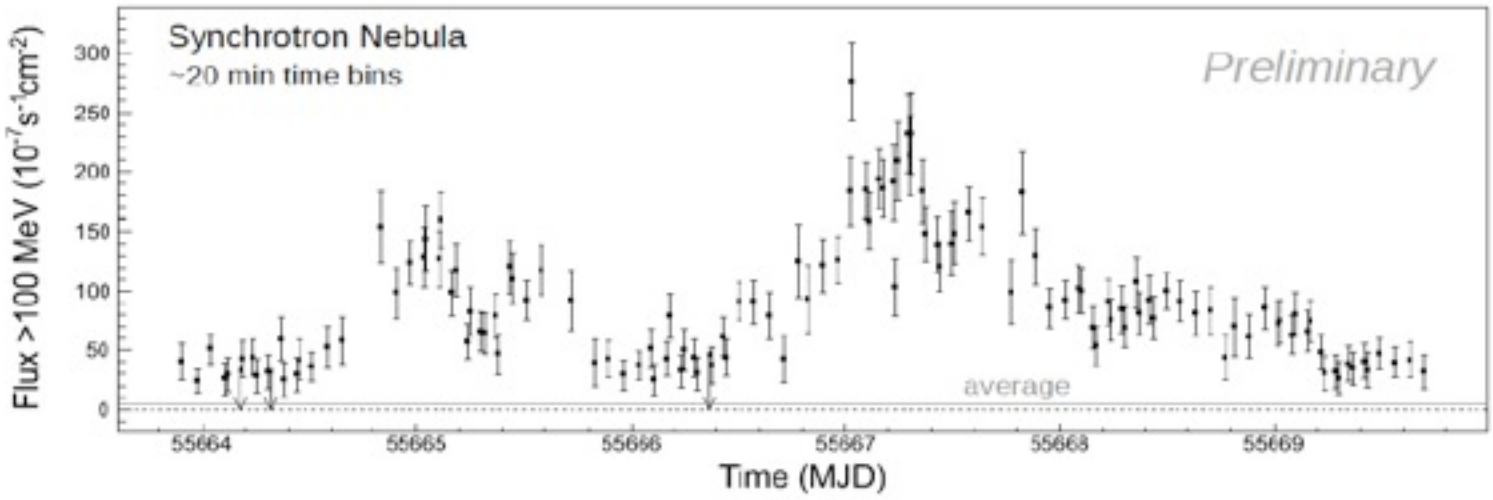
- Si Wimps relique en équilibre thermique à l'échelle électrofaible $\Rightarrow \langle \sigma_A v \rangle$ ~qqs 10^{-26} cm^3/s

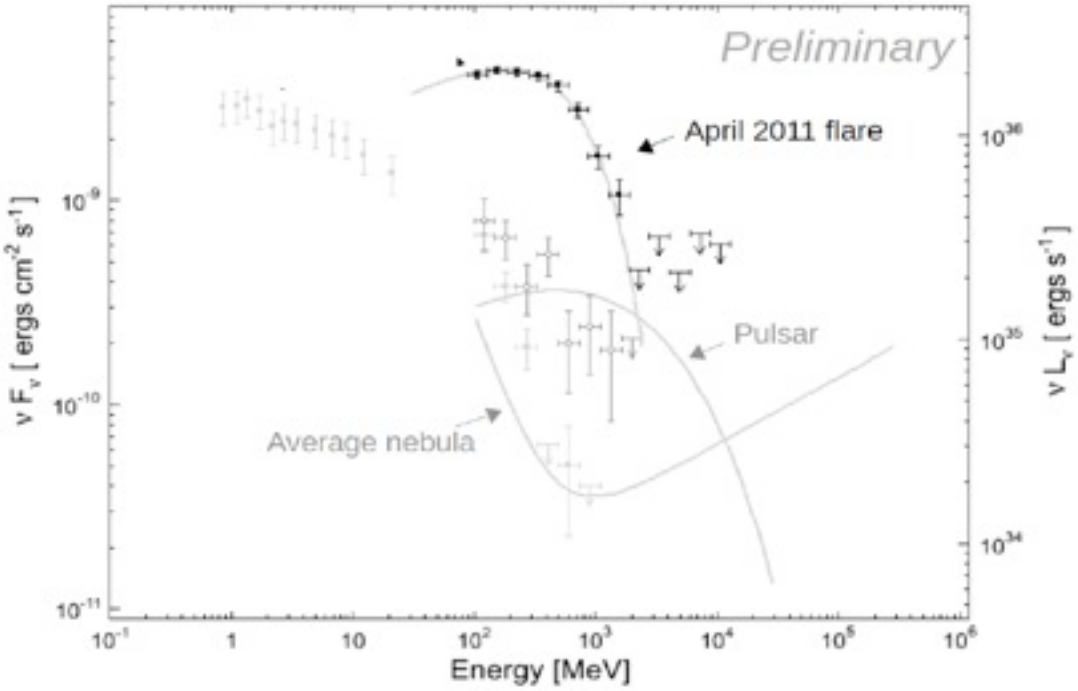
- Fermi commence à exclure cette zone….

The Crab nebula, a ”standard candle”?



Gamma-ray flares from the Crab nebula (Fermi)





- **Confirmed by Agile**
- **No change in optical (Hubble)**
- **No change in X-rays (Integral, Swift, RXTE, Chandra: knots)**
- **No change in TeV gammas (Magic, Veritas, hint in Argo-YBJ)**

Rapid (1h) change in GeV gammas
→ rapid change in PeV electrons !?!

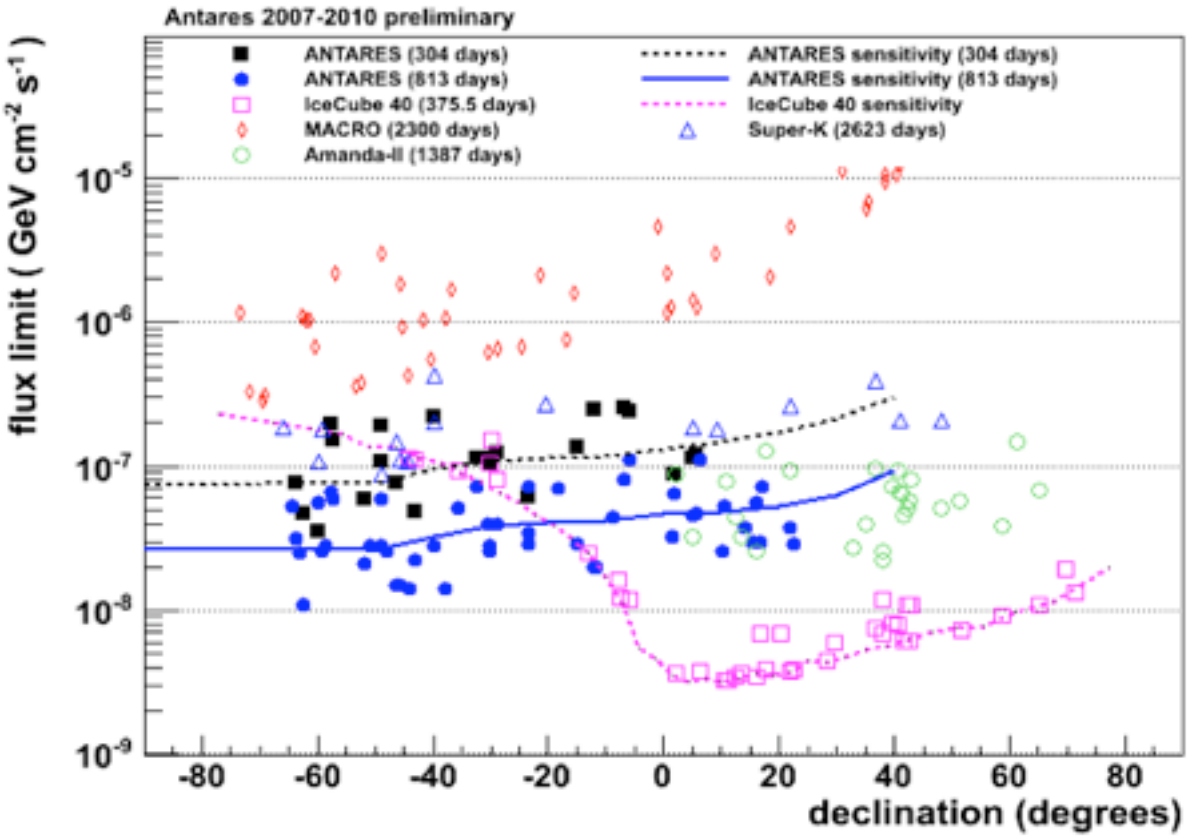
Antares: Point source search

⇒ Looking for an excess of signal events everywhere in the (visible) sky.

⇒ Most signal-like cluster at $\alpha = -46.5$, $\delta = -65.00$; it consists of 9 events inside a 3° cone.

Nsig = 5
Q = 13.02
p-value = 0.026
Significance = 2.2 σ

- '*hottest*' spot in the neutrino sky
- compatible with the background hypothesis



Energie Noire

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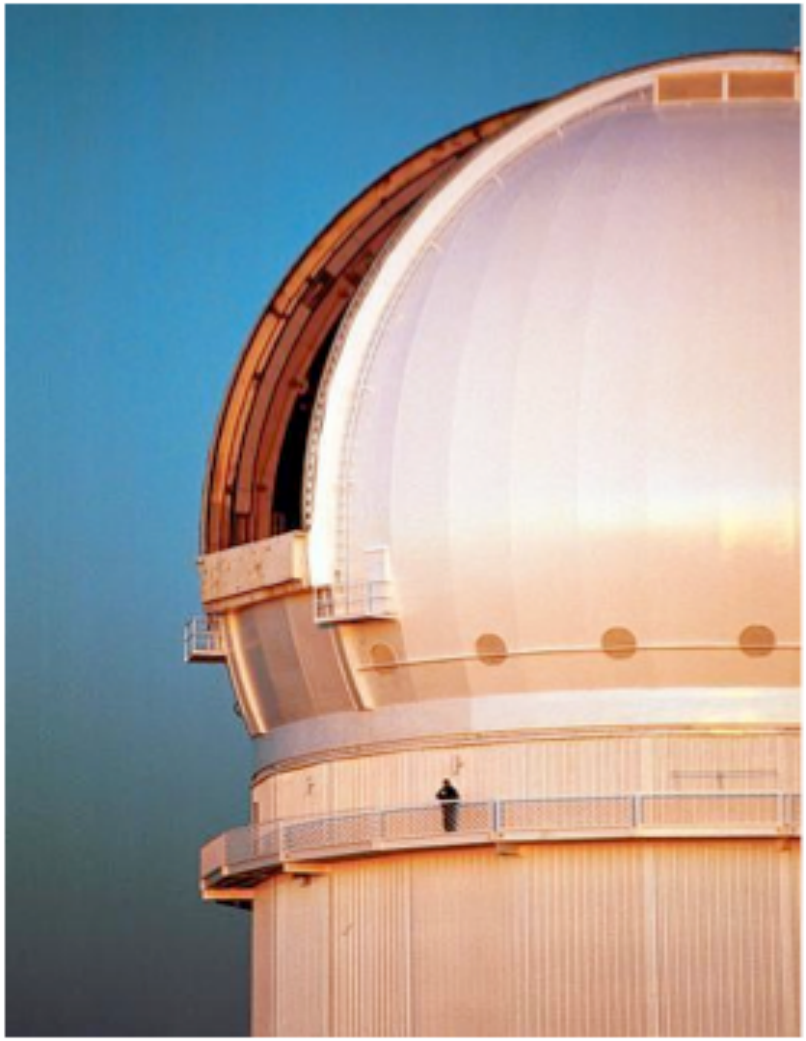
Delphine Hardin

Michael Drinkwater

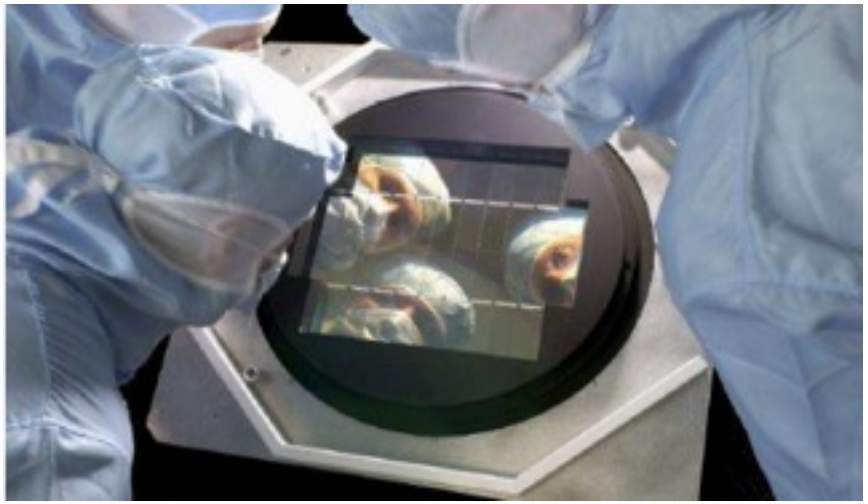
Ch. Y.



SNLS: SuperNova Legacy Survey

MegaCam:

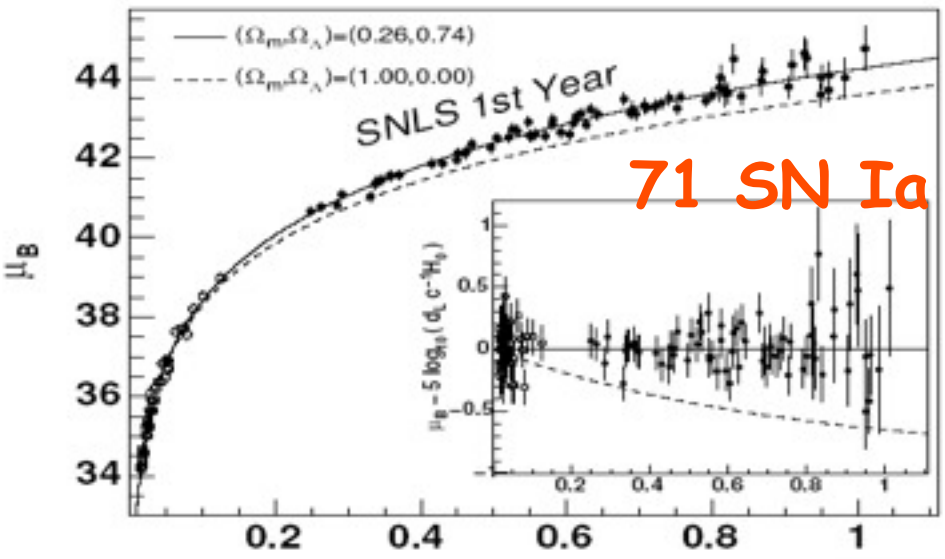
- Conçue et construite par l'Irfu
- Plus grande camera CCD au monde:
  36 CCD 2k × 4.5k pixels.
- Grand champ: 1 deg^2



SNLS:

- Télescope de 3.6m (CFHT)
  à Hawaï équipé avec **MegaCam**
- 500 SN Ia attendues (2003-2008)

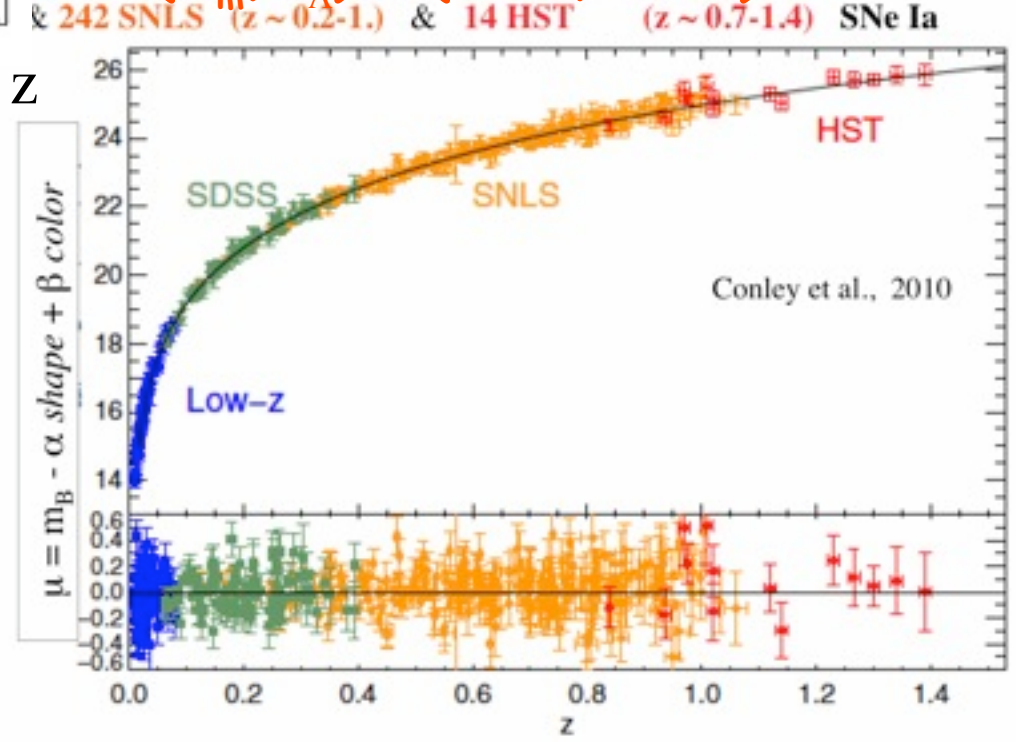
SNLS: Résultats



1 an d'observation

- **71 SN Ia** découvertes et confirmées par la spectroscopie
- Avec la première année, le diagramme de Hubble confirme l'existence de l'énergie noire et donne

$(\Omega_m, \Omega_\Lambda) = (0.26, 0.74)$



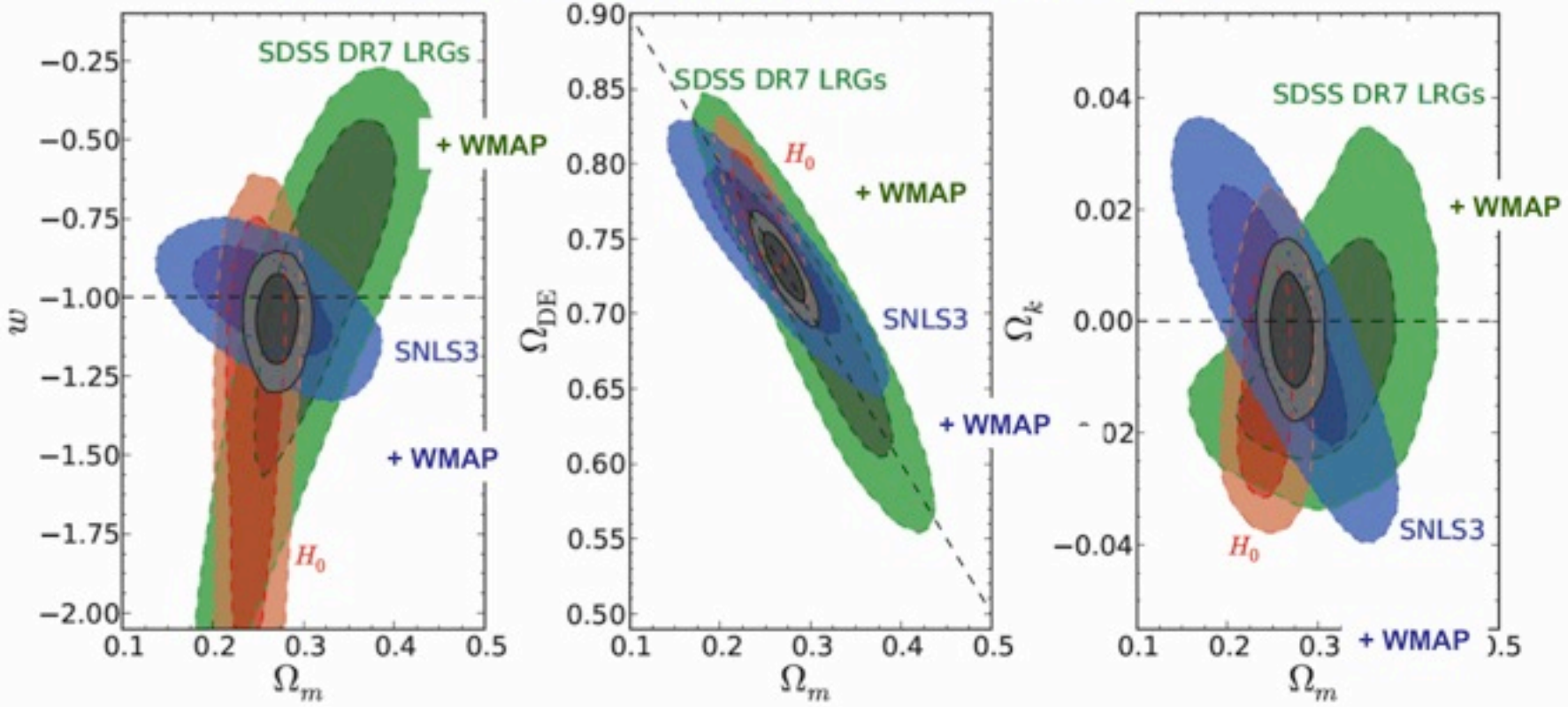
Résultats avec 3 ans:

- Etude très précises des systématiques (principale calibration photo et inter-calibrations)
- Combinaisons avec SDSS et HST

Cosmologie avec SNLS

Combining SNLS-3 with other cosmological probes :

SDSS + WMAP7 + H_0 + (no flat prior) :

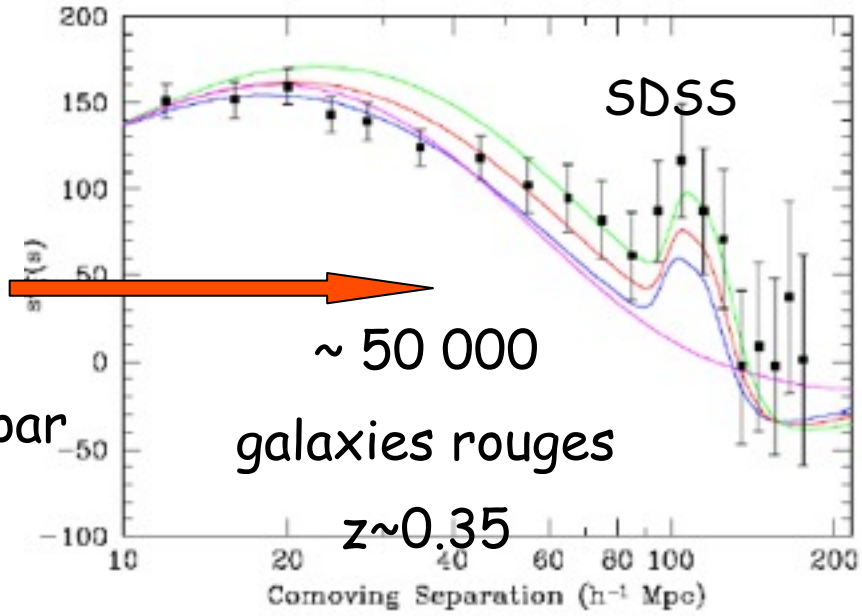


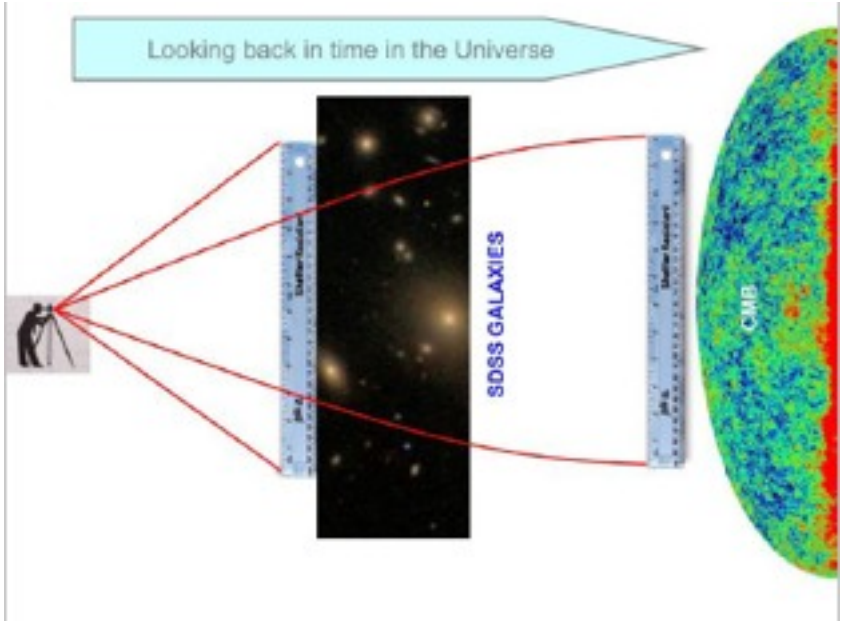
$$\Omega_M = 0.271 \pm 0.015,\ \Omega_k = -0.002 \pm 0.006,\ w = -1.069 \pm 0.092$$

BAO: Une nouvelle règle standard

Empreinte dans l'Univers:

- Les galaxies ne sont pas réparties uniformément
- Empreinte des fluctuations primordiales
- En 2005: premières observations par SDSS observe un pic à ~150 Mpc





SNIa : « Chandelles standards»

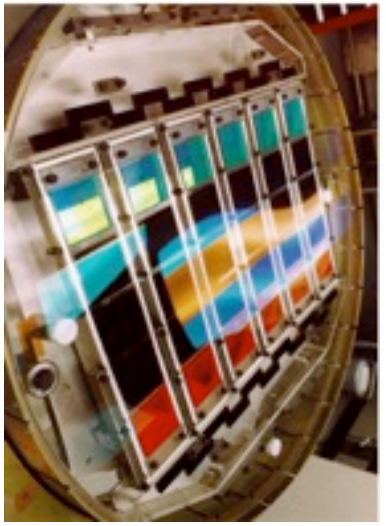
BAO : « Règle standard »

- Distorsions de la règle autour de nous dues à l'énergie noire

Energie noire avec SDSS-III/BOSS

Consortium SDSS-III

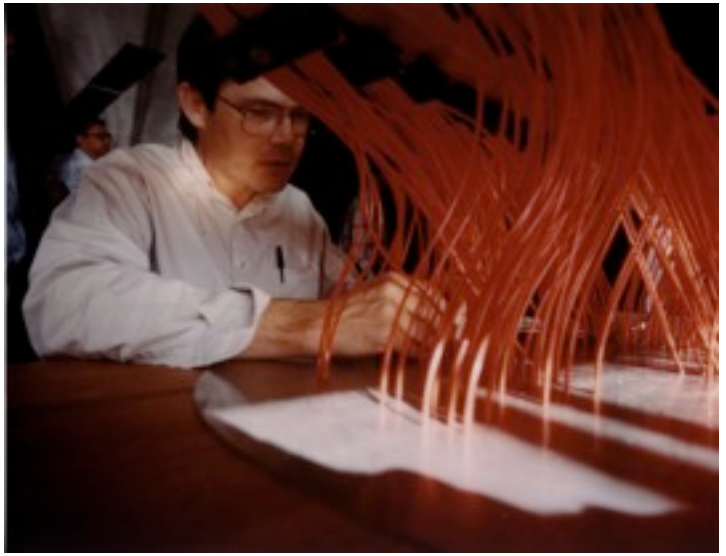
- Télescope avec un grand champ focal ~ 7 deg^2
- Caméra avec 5 filtres (~120 millions de pixels)
- Spectrographe avec des fibres optiques : ~ 1000 « z » simultanés



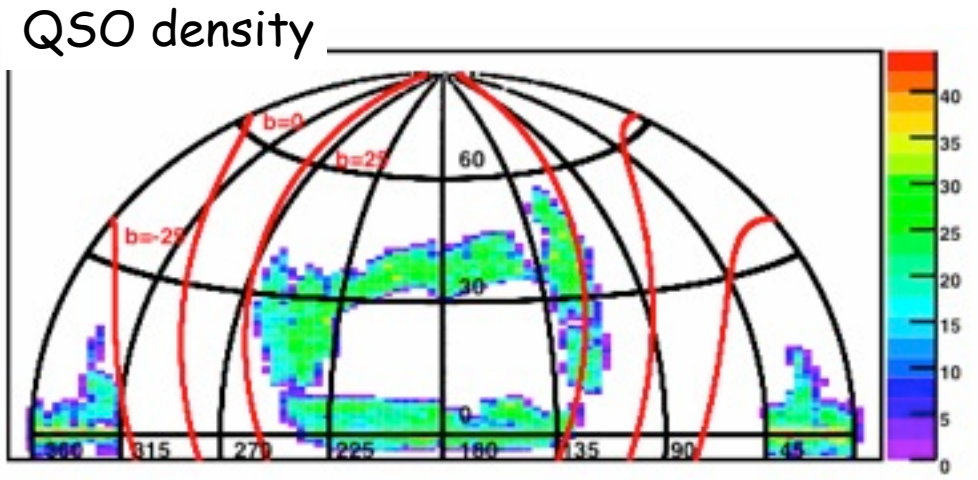
Projet BOSS

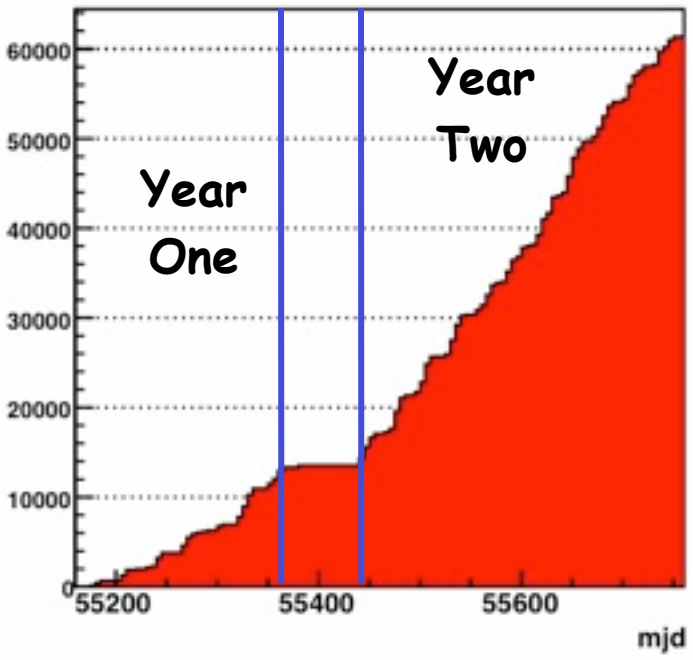
- 1.5 millions de galaxies rouges encore plus loin, jusqu'à z~0.7
- Utilisation des phares les plus lointains de l'univers:

Quasars pour 2.2<z<3.5 à 10 Milliards d'années de nous



Status BOSS of the survey





- On average ~4000 high-z QSOs per month
- So far, ~92 000 new QSOs (including ~61 500 z>2.15 QSOs) over ~4000 deg^2
- This sample (1/3 of entire survey) will be DR9 (July 2012)
- **End of the survey:** 150k - 200k high-z QSOs !!!

Ly-α forests for BAO

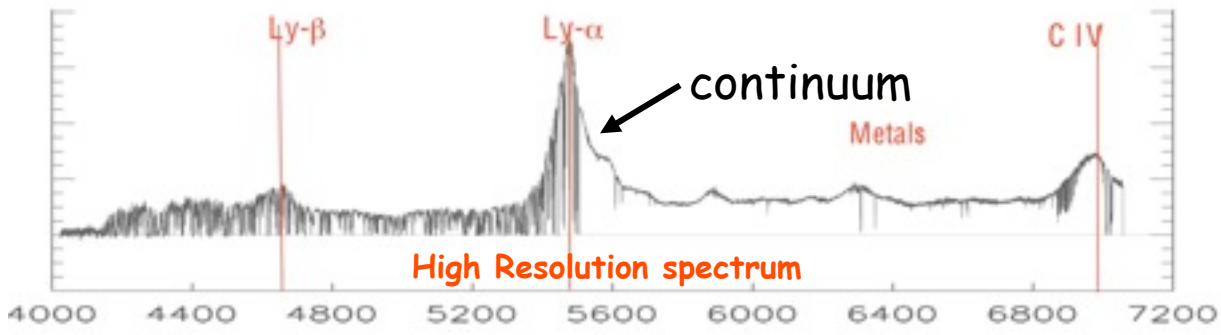
Principles

- Use Ly-α forests of quasars (2.2<z<4)
- HI absorption in IGM along the line of sight of QSOs
- We expect low density gas (IGM) to follow the dark matter density (validations : measured 1D power spectrum and N-body simulations…)

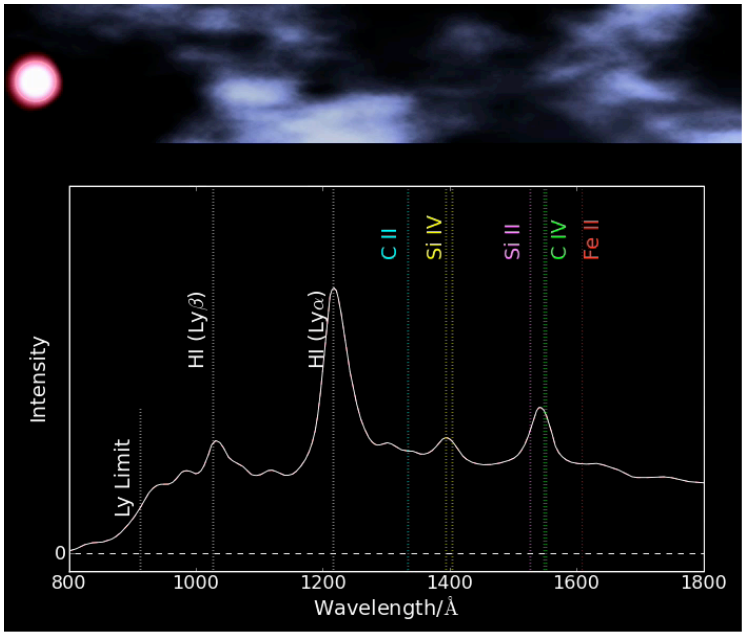
BAO specifications:

- 3D BAO: Correlation between the different lines of sight
- BAO measurement for z~2.5
- Better precision in radial direction (H(z) measurement).

z~3.6 Quasar



Ly-α forests for BAO



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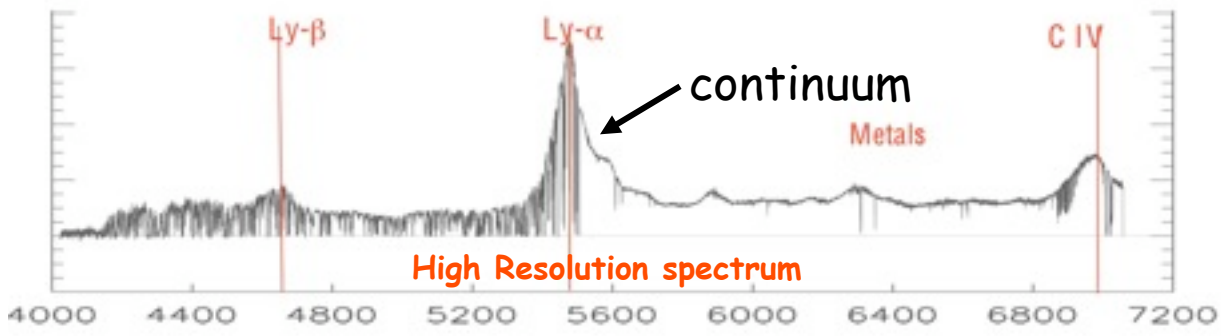
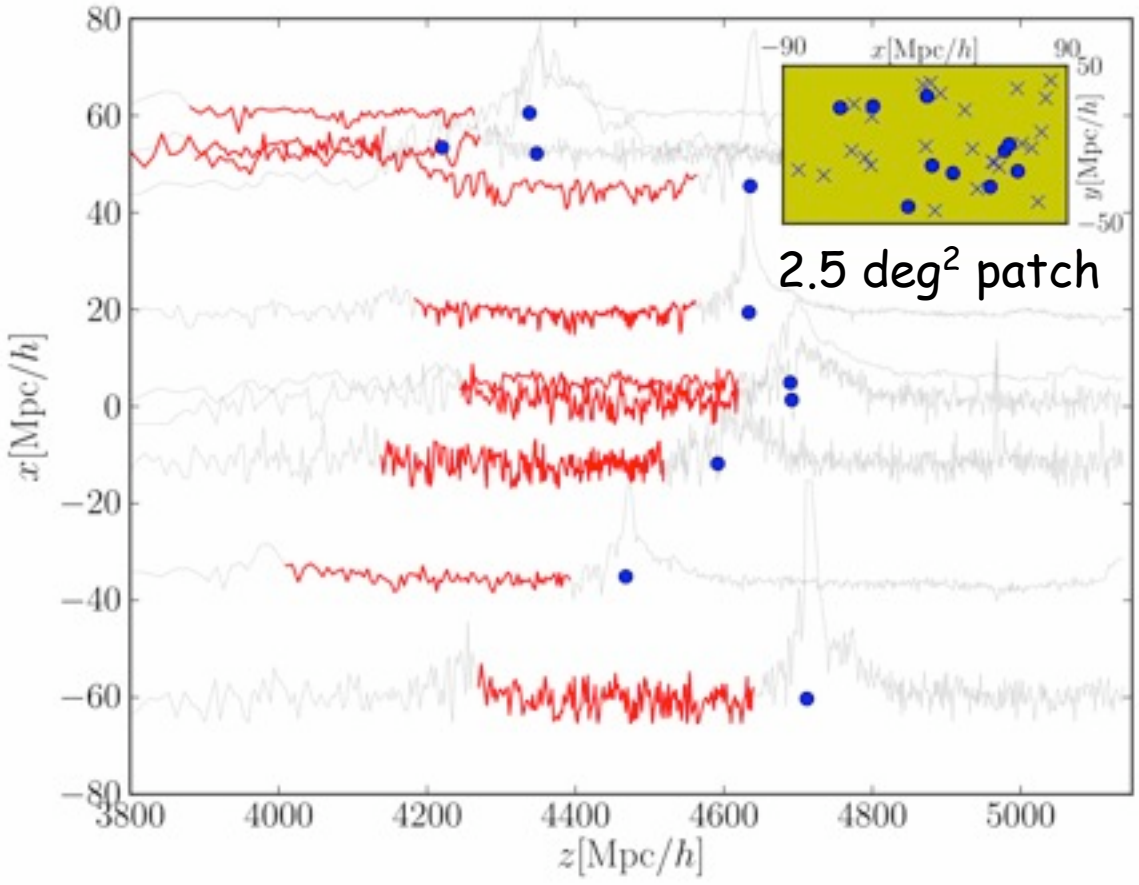
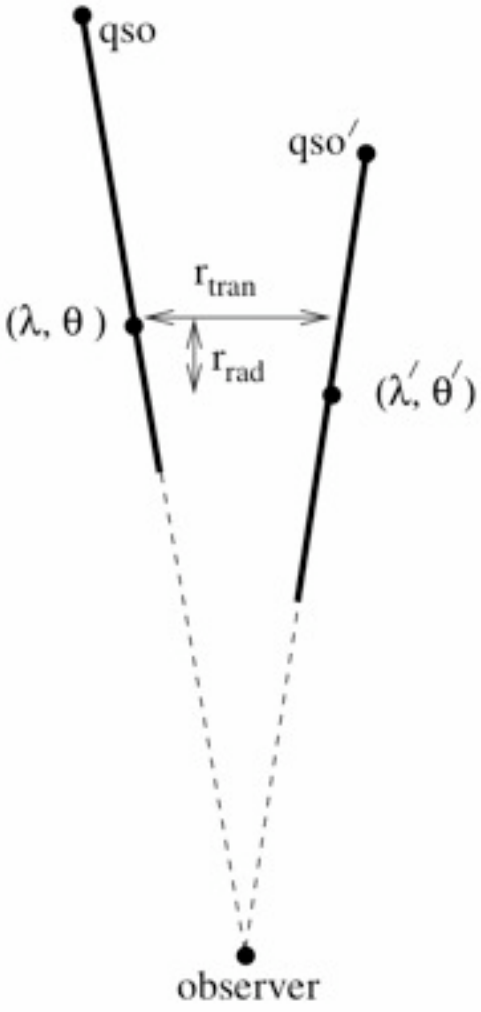


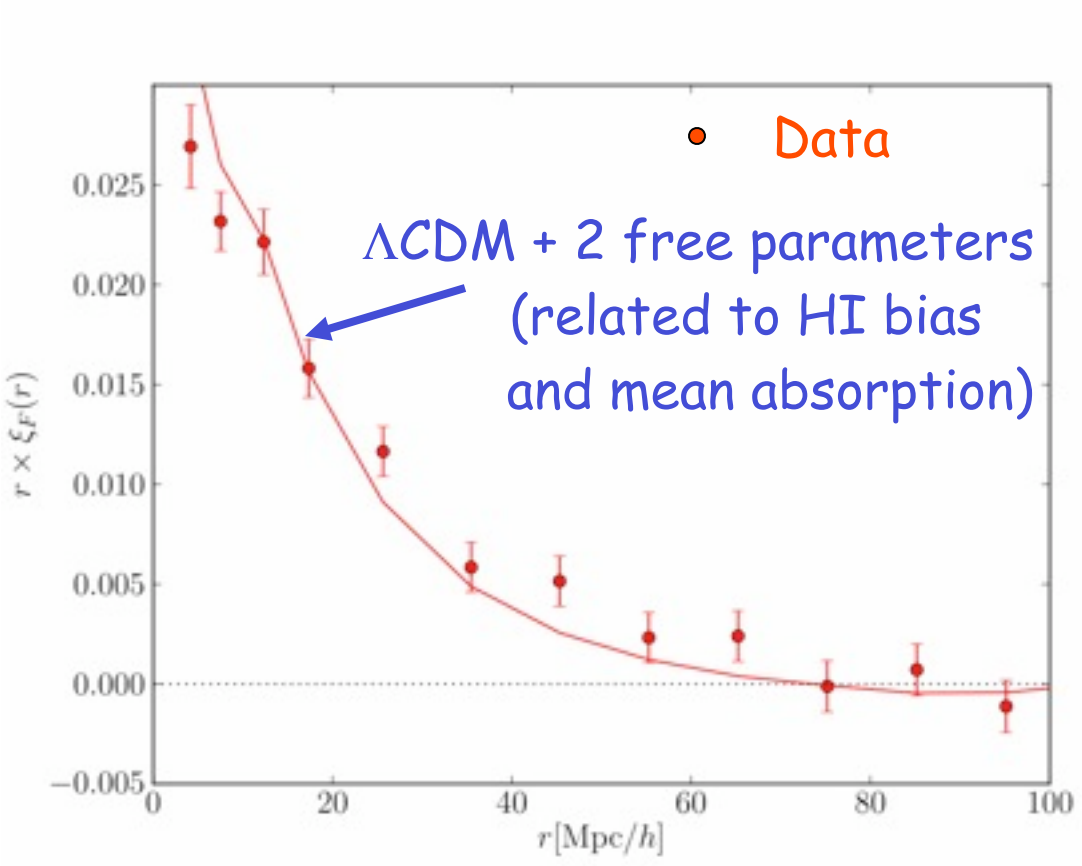
Ly-α absorption correlations

$$\xi_F(\vec{r}) = \left\langle \delta_F(\vec{x}) \cdot \delta_F(\vec{x}+\vec{r}) \right\rangle$$





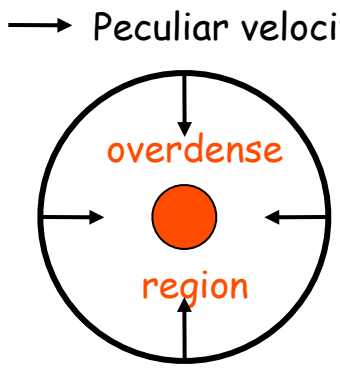
Correlation Function



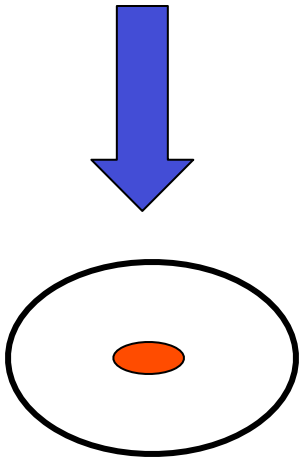
Projection over $|\vec{r}|$
of the 3D correlation function

- Correlations in HI seen to 50 Mpc/h
- First observation in 3D of matter in IGM
- Results consistent with ΛCDM simulations

Large-scale Redshift Distortions



Real Space



Redshift Space

- Acceleration toward overdense regions
- Flattening in radial direction from real space to redshift space (over tens Mpc)
- Measurable with Kaiser formula

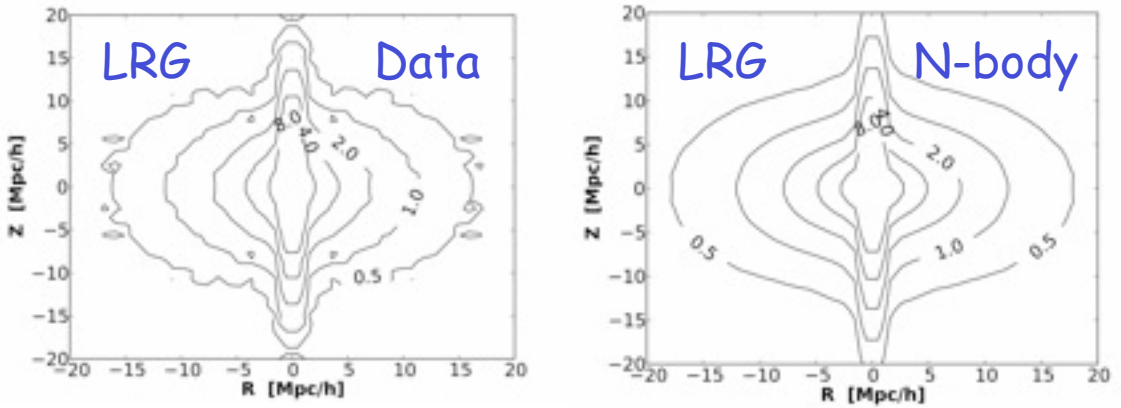
N. Kaiser

MNRAS 227, 1 (1987)"

$$P_F\left(\vec{k}\right) = P_F\left(k,\cos(\theta)\right)$$
$$= b^2 P_L(k)\cdot(1+\beta\cos(\theta)^2)^2$$

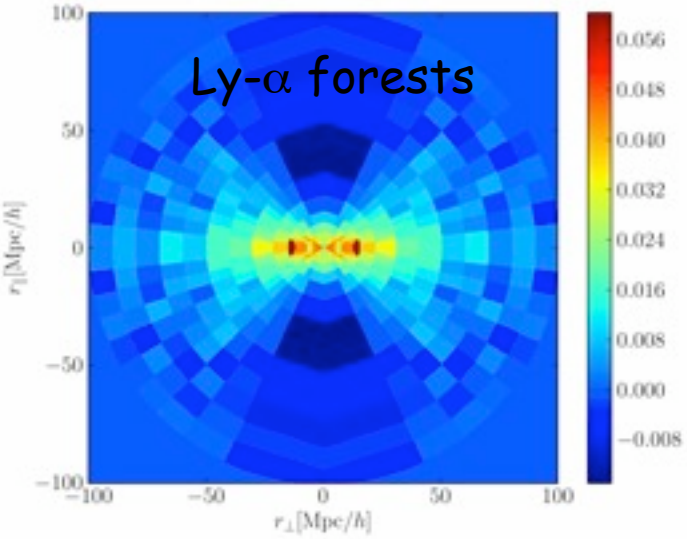
- $P_L(k)$ linear power spectrum
- θ angle between vector k and QSO line of sight

Large-scale Redshift Distortions



- Redshift distortion clearly observed with 44000 LRGs <z>~0.6 in BOSS (spring 2010)
- Excellent agreement between data and N-body simulations

M. White et al.,
ApJ 728, 126 (2011)"



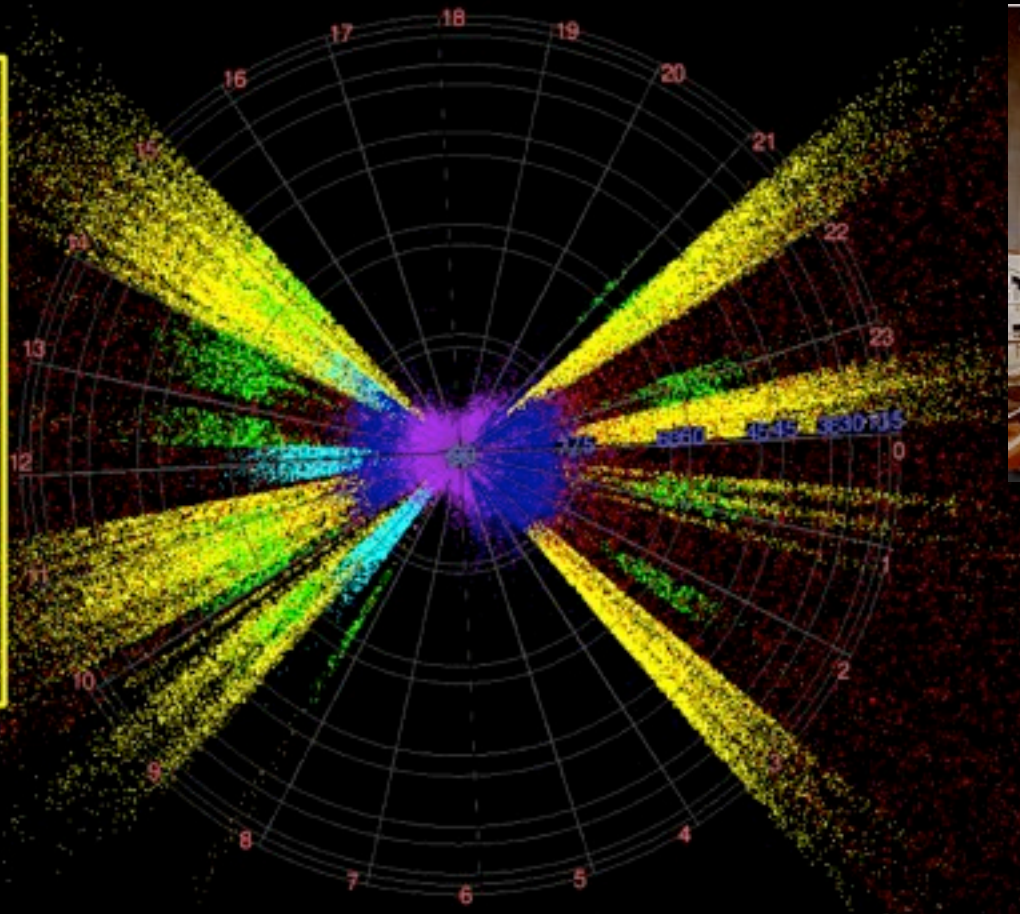
- Flattening of (r_{tran},r_{rad}) correlation function distribution
- First observation of redshift distortion at z~2.5
- Distortion are quantitatively measured by multi-poles decomposition

Wigglez

WiggleZ survey fields
(compared to other AAT surveys)

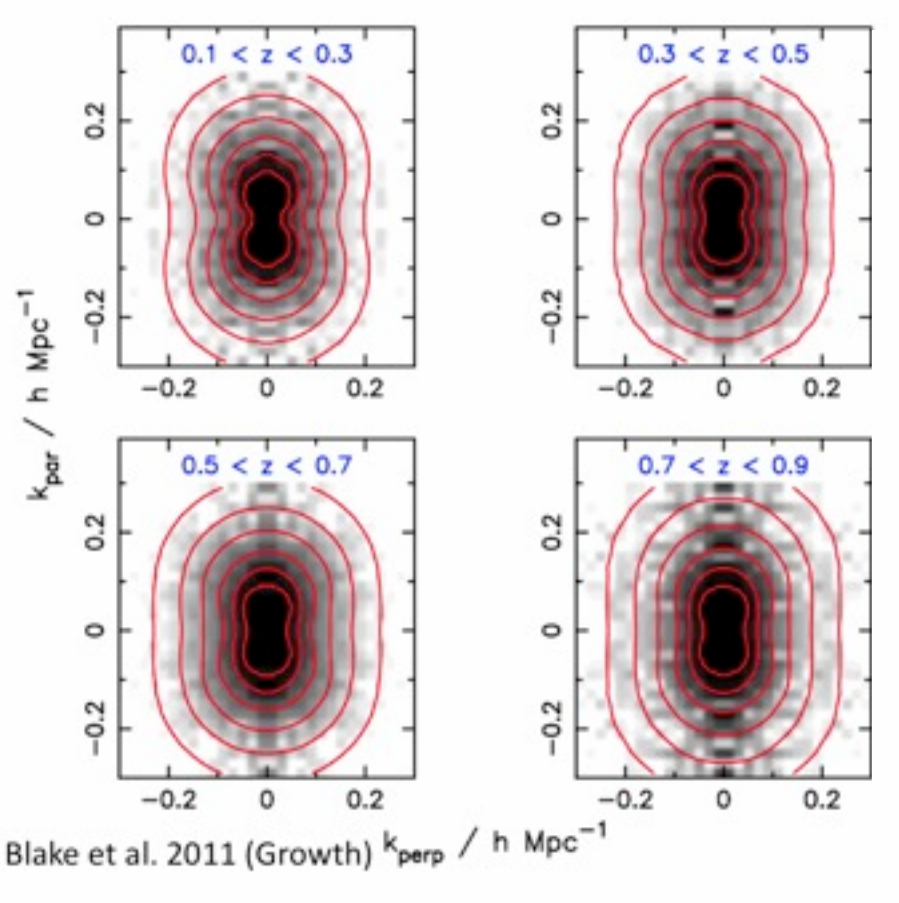
7 equatorial fields, each 100-200 deg^2
>9° on side, ~3 x BAO scale at $z > 0.5$
Physical size ~ 1300 x 500 x 500 Mpc/h

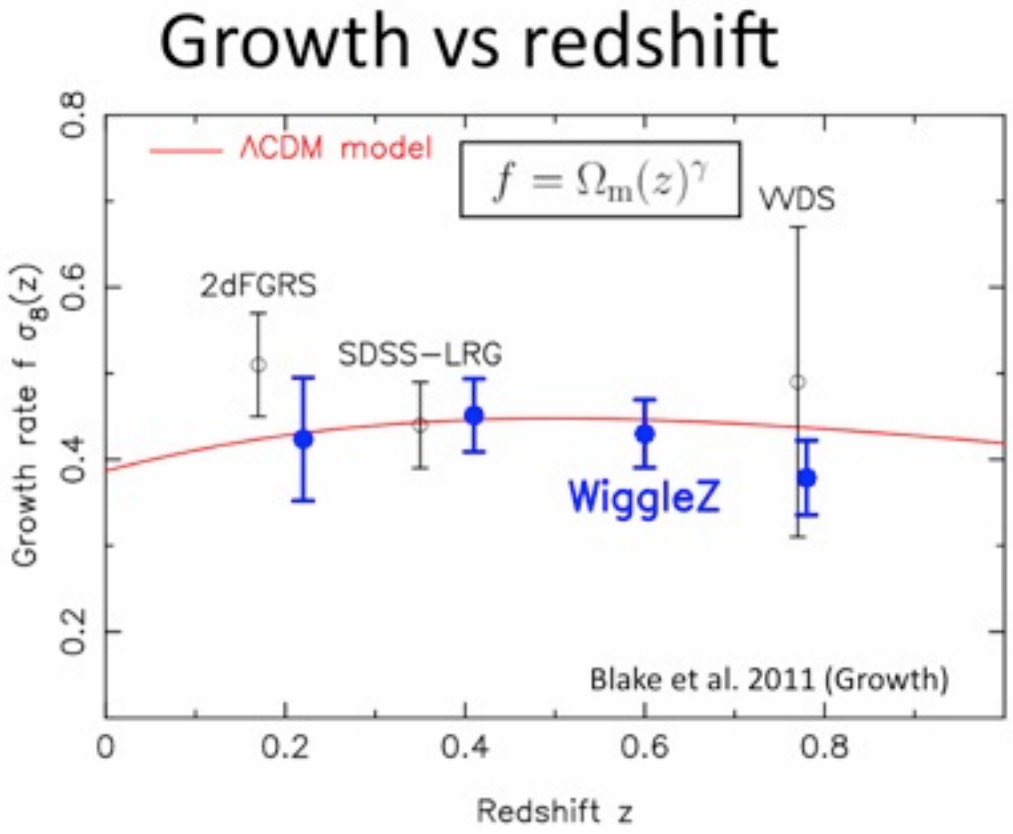
- highest-ever redshift galaxy survey
- $0.2 < z < 1.0$
- 220,000 blue galaxies
- 1 GPc^3
- Observations finished Jan 2011

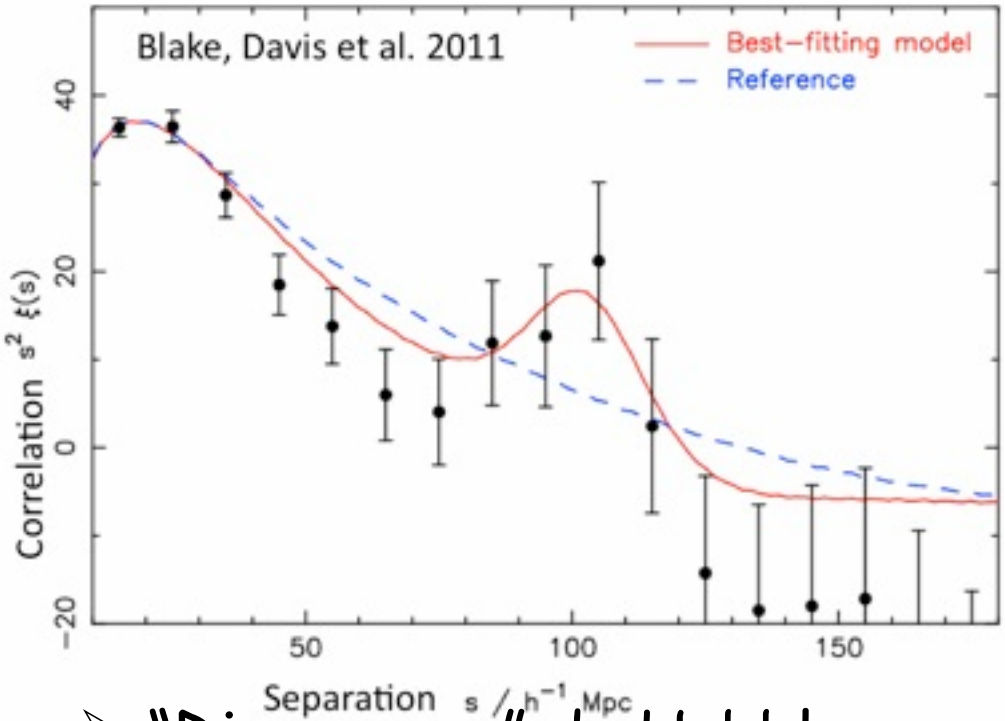


6dFGS (purple), 2dFGRS (blue), MGC (navy), GAMA (cyan), 2SLAQ-LRG (green), WiggleZ (yellow), 2SLAQ-QSO (orange), 2QZ (red); the celestial sphere is at z=1.

Wigglez - RS distorsion







Wigglez -BAO

- "Diagramme" de Hubble du BAO
- Eté 2012 futurs points à z=0.5, 0.7 et 2.5 - BOSS
- Double diagramme: Directions longitudinale et transverse